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A CLASSIFICATION OF THE VARIETIES OF CULTIVATED OATS

W. C. ETHERIDGE

ITHACA, NEW YORK
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A CLASSIFICATION OF THE VARIETIES OF CULTIVATED OATS

A CLASSIFICATION OF THE VARIETIES OF CULTIVATED OATS[1]

W. C. Etheridge

Among the varieties of oats grown in this country there is a diversity of type to fit the wide range in natural environment. Adaptiveness of the variety to local conditions is therefore a factor that directly affects the yield and the profitableness of the crop; hence the choice of a variety for given conditions and purposes should receive careful consideration.

But the choice of a variety is contingent on the establishment of the identity of the several types. The desired type must be recognized and distinguished with certainty from all other types, otherwise a proper choice is largely a matter of chance. In recent years the number of varieties has been rapidly increased by foreign introductions and by the development of plant breeding. This has resulted in a multiplicity of forms for which there are no comprehensive and accurate descriptions, and hence no means of systematic identification. Along with the increase in varietal forms have come misuses of nomenclature, similar popular names being applied to different forms, and similar forms carrying different names. The increase in number of forms, many of them scarcely different, and the confusion of their nomenclature, now make uncertain the identification of varieties by their names or general appearance. There is need, therefore, for a usable system of classification by which the grower may identify the varieties with which he is concerned. It is the purpose of this study to make such a classification of the American varieties as they appear when grown in the environment of New York State, and to clear to some extent the confusion in varietal nomenclature.

Since a knowledge of the structure of cultivated plants is of fundamental importance to the student in agronomy, the morphology of the oats plant is fully discussed herein. It is hoped that the descriptions of structural parts may be useful to those who study systematically the cultivated varieties.

---

[1] Also presented to the Faculty of the Graduate School of Cornell University, September, 1915, as a major thesis in partial fulfillment of the requirements for the degree of doctor of philosophy.

WORK OF PREVIOUS INVESTIGATORS

Although there have been in this country no reports of extensive systematic studies of varieties of oats, several methods of classification have been proposed by foreign investigators. These are found to differ widely in the arrangement of classes, and in the importance accorded various characters by which groups are distinguished and further separated into subgroups and varieties. Considerable space, therefore, is here devoted to outlining and discussing the previous systems of classification, in order to appraise them as means of identifying varieties as well as to show precedence for certain taxonomic features of the classification herein presented.

The first noteworthy systematic study of cultivated oats was by Körnicke and Werner (1885).[2] In the classification by these authors, species are distinguished by adherence or non-adherence of the lemma and the palea to the caryopsis; by the number of awns produced by the spikelet; and by the toothing and color of the lemma. Within the species, various types are distinguished by the form of the panicle; by the color of the grains; and by presence or absence of awns and hairs of the lemma. The system of twenty-nine groups thus formed is here briefly outlined:

Kernel closely invested by the hull (covered oats).
- I. Spikelets awnless or 1-awned.
  - A. Panicle equilateral, spreading.
    - a. Grains white.
      1. var. *mutica* Al. Grains white, lanceolate, awnless.
      2. var. *praegravis* Kr. Grains white, egg-shaped, awnless.
      3. var. *aristata* Kr. Spikelet 2-grained; grains white, awned.
      4. var. *trisperma* Schubl. Spikelet 3-grained; grains white, awned.
    - b. Grains yellow.
      5. var. *aurea* Kcke. Grains yellow, awnless.
      6. var. *Krausei* Kcke. Grains yellow, awned.
    - c. Grains gray.
      7. var. *grisea* Kcke. Grains gray, awnless.
      8. var. *cinera* Kcke. Grains gray, awned.
    - d. Grains brown or red.
      9. var. *brunnea* Kcke. Grains brown, awnless, hairless.
      10. var. *setosa* Kcke. Grains brown, awnless, bristly.
      11. var. *montana* Al. Grains brown, awned, hairless.
      12. var. *rubida* Kr. Grains red, awned, hairless.
    - e. Grains black.
      13. var. *nigra* Kr. Grains black, awnless.

[2] Dates in parenthesis refer to bibliography, page 163.

B. Panicle unilateral, appressed.
a. Grains white.
14. var. *obtusata* Al. Grains white, awnless.
15. var. *tartarica* Ard. Grains white, awned.
b. Grains yellow.
16. var. *flava* Kcke. Grains golden, awnless.
c. Grains brown.
17. var. *tristis* Al. Grains brown, awnless.
18. var. *pugnax* Al. Grains brown, awned.

II. Spikelets with 2 or more awns.
19. var. *brevis* Roth. Grains short, the lemma without awn points.[3]
20. var. *strigosa* Schreb. Lemma with 2 long awn points.
21. var. *abyssinica* Hochst. Lemma 4-toothed, white, extending far above the kernel.
22. var. *Schimperi* Kcke. Lemma 4-toothed, yellow, extending far above the kernel.
23. var. *Hildebrandti* Kcke. Lemma 4-toothed, gray, extending far above the kernel.
24. var. *Braunii* Kcke. Lemma 4-toothed, brown, extending far above the kernel.

Kernel free within the hull (naked oats).

I. Panicle equilateral, spreading.
25. var. *inermis* Kcke. Grains awnless.
26. var. *chinensis* Fisch. Spikelet with 1 awn.
27. var. *nuda* L. Spikelet with 2 awns.

II. Panicle unilateral, appressed.
28. var. *gymnocarpa* Kcke. Grains white.
29. var. *affinis* Kcke. Grains brown.

In their classification according to the preceding outline, Körnicke and Werner have brought together 137 varieties representing an exceedingly wide range of structure; but within each group there is no systematic separation of closely related varieties, they being arranged in no particular order although minutely described. That part of the system which distinguishes species and types is especially suggestive for contemporary work, but the method of grouping many varieties of the same general type without further systematic arrangement is not satisfactory since it leaves the identification of varieties within a group to a tedious comparison of their descriptions. Böhmer (1908–09) has criticized the classification of Körnicke and Werner as bringing together varieties alike in superficial characters but not systematically related in physical properties. However, this criticism seems lacking in point, for a system for the identification and competent description of varieties of oats must primarily be based on morphological rather than physical differences.

[3]In a more detailed description of var. *brevis*, Körnicke states that the point of the grain is usually blunt, with two short, firm teeth which occasionally are lengthened into awn points.

Atterberg (1891) classified the varieties of oats found in northern and western Europe mainly on the basis of differences in the prevailing number of grains in the spikelet, and on the absolute weight of grains and their percentage of kernel. The form of grains was used to subdivide one group, while color of grains and form of panicles were employed only as secondary characters to distinguish varieties which were alike in physical properties. Atterberg's system was as follows:

A. Spikelets so inclined to 3 grains that middle grains are usually present; single grains few.
   - I. Grains containing 59–68 per cent of kernel.
     - a. Grains small; 1000 grains = 25–31 grams.
     - b. Grains medium; 1000 grains = 32–38 grams.
     - c. Grains large; 1000 grains = 39+ grams.
   - II. Grains containing 69–73 per cent of kernel.
     - a. Grains small; 1000 grains = 25–32 grams.
     - b. Grains medium; 1000 grains = 33–38 grams.
     - c. Grains large; 1000 grains = 39–45 grams.
   - III. Grains containing 74–79 per cent of kernel.
     - a. Grains small; 1000 grains = – 32 grams.
     - b. Grains medium; 1000 grains = 32–38 grams.
     - c. Grains large; 1000 grains = 39+ grams.

B. Spikelets commonly with 2 grains, never with 3 grains; 1-grained spikelets numerous.
   - IV. Grains containing 69–73 per cent of kernel.
     - a. Grains small; 1000 grains = 25–32 grams.
     - b. Grains medium; 1000 grains = 33–38 grams.

C. Spikelets usually with 1 grain; spikelets with 2 grains often occurring.
   - V. Pointed grains.
   - VI. Short grains.
   - VII. "Barley" grains.
   - VIII. Full, plump grains.

Under these groups and types the grains of 102 varieties are described. In order to understand and appraise Atterberg's system his descriptions of the above classes must first be reviewed. These are as follows:[4]

Spikelets with 2 grains.— In these the outer and inner grains differ in size and form. Roughly, the weight of outer grains is 1.6 times that of inner grains; they are longer, more pointed, and their inner side is usually somewhat flat. Inner grains are short-pointed and more rounded than outer grains, although their base is somewhat pointed while that of outer grains ends bluntly. Unlike outer grains, inner grains are never bearded[5] and the rhachilla is absent or reduced to a thin, hair-like appendage bearing a rudimentary third grain.

Spikelets with 1 grain.— When inner grains fail to form, the outer ones become normal single grains, their inner side convex. The rhachilla is then longer, thinner, and carries a large membrane or rudimentary third grain. Single grains are usually smaller than outer grains, but like them have on their inner side the connecting point for another grain. As with outer grains, the bases of single grains end abruptly.

Spikelets with 3 grains.— On the development of the rudimentary flower borne by the inner grain the spikelet bears 3 grains, the third grain becoming in form much like the second.

[4]Translation from the original German.
[5]Atterberg evidently worked only with *Avena sativa* and *Avena sativa orientalis.*

Double grains.— When under unfavorable weather conditions at maturity the outer grain fails to become fully developed, its lemma often completely envelops the inner grain and causes the condition of "double grain." Because of this abnormality, double grains are of no importance in classification, but they should never be confused with single grains.

According to Atterberg none of the above four forms of spikelets are carried by every variety in like number, and it is only the prevailing form in a given variety that determines its group relationship. Classes arranged on this basis, therefore, cannot be constant, but are transitional, passing into one another under changes in climatic and soil conditions; and hence no variety can by this system rightly be classified under a single condition of environment.

The following forms of grains are believed by Atterberg to be more constant than the number of grains in the spikelet:[6]

"Barley" grains. — Single grains prevail in this type, but the second grain, when present, shows the same short, heavy, full, compact form as the first grain. The lemma is strongly developed and on single grains nearly, often entirely, covers the palea. If the palea is not visible the grain is called "closed"; if a part of it can be seen the grain is designated as "open." When the second grain is present the lemma of the outer grain commonly has its edges so inrolled as to form a gutter.

Pointed grains.— The grain of this type is widest at, or just below, the upper end of the rhachilla; it is longer than the "barley" type and the edges of its lemma are rolled into a hard, stiff point. Spikelets with 2 grains are more numerous than in "barley" oats, 1-grained spikelets seldom predominating. In all other respects of shape than those mentioned the grains are similar to the "barley" type.

Full, plump grains.— Grains of this type are rich in kernels; they are full, plump, short, and borne on weak peduncles; and the inner side of the first grain is strongly convex as compared with the usual guttered form. The lemma is more free from the caryopsis than in most forms. If the point of the grain becomes weak and longer drawn, the form passes to the pointed-grain type.

Short grains.— When grains of the above type become weaker and more convex on their inner side they assume a shorter, rounder form and pass to the short-grain type. The edges of the lemma then cover the greater part of the palea.

Hulled grains.— In northern Germany a very long, thin, long-pointed type is called "chaffy" or "hully" (spelzig) oats. This type has many 3-grained spikelets.

Aside from its comprehensive descriptions of spikelet and grain forms, Atterberg's classification is subject to criticism because of the characters used to distinguish main groups of varieties. The absolute weight of grains, their kernel content, and their form, are too easily influenced by environment to afford a reliable means of distinction; there would be, in response to change of climate and soil, an interchange of varieties among groups thus characterized. Again, by Atterberg's method of grouping, varieties morphologically unlike may be brought together; and, on the

[6]Translation from the original German.

other hand, forms that are closely related structurally may be placed in widely different groups on the basis of variation, induced by environment, in the weight and kernel content of their grains. The system, while probably useful in grading the quality of grain, is of little use for the permanent classification and identification of varieties.

Denaiffe and Sirodot (1901), in their studies of the cultivated oats of France, have distinguished 76 varieties. The main groups of varieties arranged by these authors are characterized by the form of panicles, and by the color, form, and size of grains. The form of panicles, however, is used only in the minute descriptions of individual varieties and does not appear in the following system for the identification of varieties, here rearranged from the original diagrammatic outline:

I. Grains white, white-yellowish, or yellow.
  A. Duckbill grains, plump, open-pointed; lemma flattened, very white.
    B. Outer grains 12–14 mm. long; numerous 1-grained spikelets; rhachilla nail-headed, fine, long; grains double.
      C. 2-grained spikelets predominant; 1-grained spikelets numerous; grains very duckbill-like.
        D. Grains barley-like, 13–14 mm. long, variable, large, plump; lemma extremely flat; 1000 grains weigh 38–42 grams.
        DD. Small barley-like grains; outer grains 12 mm. long, duckbill-like, and often bearded; single grains large; 1000 grains weigh 34–35 grams.
      CC. 1-grained spikelets predominant; grains of the intermediate barley-like type; outer grains 13.5–14.5 mm. long, variable; single grains less plump and longer; 1000 grains weigh 38–42 grams.
    BB. Outer grains 15–16 mm. long, large, plump, swollen, large-pointed, and duckbill-like; 1-grained spikelets not occurring; awn usually present and geniculate; rhachilla flat, short, and hairy at the summit; 1000 grains weigh 47–49 grams.
  AA. Grains not plump, slightly spreading at the point, rather slender; lemma convex, white, white-yellowish, or yellow; no double grains.
    B. Grains medium-sized, swollen and full, yellowish, rarely very yellow, variable; rhachilla 2 mm. long, and with 2 furrows; 1000 grains weigh 40–46 grams.
      C. Outer grains 14–15 mm. long, slightly plump, medium full; palea rather large at point; lemma convex; 1000 grains weigh 43–46 grams.
      CC. Outer grains 15–16 mm. long, not plump, scarcely full; lemma generally flattened; palea rather pointed; 1000 grains weigh 40–43 grams.
    BB. Grains small, slightly swollen and slender; rhachilla fine, 3 mm. long, without furrows, nail-headed; 1000 grains weigh 34–39 grams.
      C. Grains white or slightly yellowish.
        D. Grains white-yellowish, variable, intermediate in size; base of the grain with lips of the scar unequal; 1-grained spikelets not occurring.
        DD. Grains white, narrow, slender, small, often bearded; base of the grain small and straight, with lips of the scar almost equal; 1-grained spikelets numerous.

CC. Grains very yellow.
D. Grains yellow, small, slightly bent; lips of the scar at base of grain slightly unequal.
DD. Similar to D, except that the base of the grain is straight and small, with a scar the lips of which are unequal. The plant is further distinguished by the form of its panicle.

II. Grains black, red, or gray.
A. Outer grains 14–16 mm. long, rarely awned; awn, if present, fine and straight.
B. Outer grains small, 14–15 mm. long; 1000 grains weigh 33–38 grams.
C. Grains small, barley-like, 14 mm. long, usually very black, large and very plump, with open points; 1-grained spikelets not occurring; awn absent; rhachilla ciliate; lemma very flat.
CC. Grains small, more or less slender; 2-grained spikelets predominant; 1-grained spikelets few.
D. Grains medium small, with oblique basal scar having unequal lips; grains very plump but variable; lemma very convex; 1-grained spikelets few or not occurring.
1. Grains black and full; nerves of lemma obscure; rhachilla slightly ciliate; basal hairs silky.
2. Grains brown; nerves of lemma prominent and more or less reddish; base of the grain smaller than in the preceding form.
3. Grains iron gray to dark and almost black; nerves of lemma obscure; rhachilla smooth; basal hairs absent.
DD. Grains black, straight, narrow, with slender and more or less reddish points; basal scar small, with equal lips; 1-grained spikelets numerous; awns frequent.
BB. Outer grains of medium but variable size, yellow-reddish; lemma usually flat with its nerves usually prominent; rhachilla short and nail-headed; basal scar large, oblique, and with unequal lips; 1-grained spikelets not occurring; 1000 grains weigh 38–44 grams.
AA. Outer grains 17–18 mm. long; awn usually present, long and geniculate.
B. Outer grains large, long, very full, uniform in size; 1000 grains weigh 46–50 grams.
C. Grains very black, large and full; awn present; base large, and its scar having unequal lips; basal hairs present, silky.
CC. Grains gray or gray-blackish, large and full, with smaller proportion of awned grains than in preceding group; nerves of lemma usually prominent; basal hairs absent.
BB. Grains long and thin, not uniform in size; 1000 grains weigh 43–46 grams.
C. Grains black, slender, very often awned; palea slightly open or pointed; rhachilla stout, ciliate; basal scar large, with unequal lips.
CC. Grains gray and more or less dark, very slender, very pointed, and rather often awned; nerves of lemma usually prominent; base of the grain and basal scar of medium size; basal hairs present in a thick ring.

In the exclusive use of grain characters for the identification of varieties, Denaiffe and Sirodot frequently make their characterizations of sections so minute and elaborate as to greatly lessen the practical usefulness of their system. Another fault is the prominent use of absolute measurements and weights and of the terms *plump, slender, duckbill,* and *barley-like* for the description of grains. Such terms have not sufficient meaning to

distinguish groups of varieties clearly; and, moreover, divisions by these means are not likely to remain stable under radical changes of environment. However, the more definite morphological characters used by the French authors are among those which must inevitably have a place in any comprehensive system for the identification of varieties of oats.

The Svalöf system, published by Nilsson (1901), is based on five distinctions in the form of panicles, each so-called type of panicle being coordinated with light- and dark-colored grains. The number of grains in the spikelet, the form and the maturing period of grains, and the quality of culms, are used as supplementary characters. Many fine distinctions in the form of panicles and the color of grains are employed for the description of single varieties. The Svalöf system may be outlined as follows:

I. Varieties with white grains and side panicles. Panicle feather-like, long and small, one-sided, greatly inclined, and pectinate; primary branches stiff, upright, appressed. Grains 2–1 per spikelet, white, small, hard, more or less slender, spindle-like, and short-pointed. Generally late in ripening. Culms hard and stiff.

II. Varieties with black grains and side panicles. Panicle, form of grain, ripening period, and culm as in I.

III. Varieties with white grains and stiff panicles. Panicle stiff, short, broad, formed like a one-sided pyramid, somewhat drooping; primary branches strong-upstanding; points numerous. Grains 2–3 per spikelet, white, large, plump, more or less oval, blunt-pointed. Generally medium early in ripening. Culms inclined to be stiff.

IV. Varieties with black grains and stiff panicles. Panicle, form of grain, ripening period, and culm as in III.

V. Varieties with white grains and wide-spreading panicles. Panicle spreading, long, bushy, all sides pyramid-like, branches long, slender, weak-upstanding, the lower ones at least being strongly drooping and with pendant spikelets. Grains 3–1 per spikelet, very long but narrow, thin, and especially long-pointed. Often early-maturing, although some varieties mature late. Culms usually weak.

VI. Varieties with black grains and wide-spreading panicles. Panicle, form of grain, ripening period, and culm as in V.

VII. Varieties with white grains and spreading panicles. Panicle spreading, all sides equal, its periphery oval; branches arched-upstanding, bare, spreading, irregular, the secondary branches strong; point short, somewhat knee-like. Grains 1–2 per spikelet, white, short, thick, hard, almost entirely inclosed by the lemma of the first grain, blunt, and short-pointed. Maturing period timely. Culms weak and brittle.

VIII. Varieties with black grains and spreading panicles. Panicle, form of grain, ripening period, and culm as in VII.

IX. Varieties with white grains and loose panicles. Panicle loose, all sides equal, long, slender, pyramid-like; primary branches short, erect, weak. Grains 1–2 per spikelet, very small but unusually plump, oval, and either blunt- or sharp-pointed. Maturing either timely or very late. Culms always weak.

X. Varieties with black grains and loose panicles. Panicle, form of grain, ripening period, and culm as in IX.

Under each of the preceding types the varieties are grouped and further distinguished by more particular descriptions, including minute differences in color of grains, presence and number of awns, and, occasionally, character of glumes. For example, Black Bell and Black Goldregen, Type IV, are thus described:[7]

Black Bell.— Panicle slender, stiff; grain chocolate-colored, spindle-like, hard, coarsely awned; glumes yellowish white, broad, bell-like; culms unusually stiff. Early-maturing.
Black Goldregen.— Panicle elegant; grain chestnut-colored, short, oval, wide open, very plump; awns few; glumes white, broad; culms strong, numerous.

The chief fault of the Svalöf system is in the lack of distinction between the panicle types of its main classes. The side, or unilateral, panicle, Types I and II, may easily be distinguished from all other forms, but among panicles of the spreading, or equilateral, type the transition of form would make an accurate classification very difficult. The system may be useful for the general description of varieties, but it can scarcely be employed for systematic identification.

Böhmer (1908–09) used for the classification of 92 varieties the panicle types characterized by Nilsson and the spikelet and grain forms described by Atterberg. The following outline of Böhmer's system includes seven main groups and twenty-two subgroups:[8]

I

A. Panicles stiff, short, mostly a "one-sided" (actually three-sided) pyramid, with sloping-upstanding, strong, main branches, the whole strongly acute; culms sufficiently stiff; ripening period generally medium early; 2–3-grained spikelets; grains large, full, blunt-pointed, and more or less oval.
   a. Bright grains.
   b. Dark grains.
   Side-panicle varieties with similar forms of grain.

B. Panicles similar to those of A, but more elegant in form; culms similar to those of A; ripening period early to medium early; 2–3-grained spikelets; grains medium, less full than those of A, more shriveled, and finer-hulled.
   a. Bright grains.
   b. Dark grains.

II

Panicles long, pyramid-formed, with long, slim, weak-ascending, wide, out-spreading branches which droop at the ends; apices of panicles meager and often drooping; culms weak; ripening period often early, but one variety is late in ripening; 3–1-grained spikelets; grains very long, long-pointed, shriveled, and meager.
   a. Bright grains.
   b. Dark grains.
   Side-panicle varieties with similar forms of grain.

[7] Translation from the original Swedish.
[8] Translation from the original German.

III

A. Panicles spreading, oval, irregular, short, with short, upstanding branches; apex of panicle short and somewhat inclined; culms usually weak; ripening period seasonable; outer grains open, mostly concave on their inner side, short, and blunt-pointed, the points weaker than in the pointed-grain forms; single grains entirely, or almost, closed and less numerous than among the "barley" types.
   a. Bright grains.
   b. Dark grains.
   Side-panicle varieties with similar forms of grain.

B. Panicles and culms similar to those of A, but larger; ripening period also as in A; grains large, thick, plump, and closed or almost closed, concave on their inner side, and with slim, weak points; many double-grains.
   a. Bright grains.
   b. Dark grains.
   Side-panicle varieties with similar forms of grain.

IV

A. Panicles long, slim-pyramidal in form, sparsely branched, all branches short, the main ones horizontal or loose-hanging; culms generally weak; ripening period seasonable to late; 1–3-grained spikelets; outer grain widest at upper end of rhachilla, and with sharp, stiff, closed or almost closed, points.
   a. Bright grains.
   b. Dark grains.

B. Panicles and culms similar to those of A; ripening period very early; 2–1-grained spikelets; grains fine-hulled, short, cylindrical, wide open, with blunt, short points.
   a. Bright grains.
   b. Dark grains.

Böhmer's classification cannot be said to distinctly differentiate groups of varieties. The panicle types adopted from Nilsson's classification are, as pointed out in the discussion of that system, lacking in the distinctiveness necessary for accurate identification; and the descriptions of grain forms selected from Atterberg's classification serve only to characterize in the most general terms the appearance of grains without distinguishing their morphological differences. Böhmer's system, therefore, does nothing more than present somewhat indefinite groups of vaguely characterized varieties, and it is in no respect a usable system for identification.

SUMMARY

From the foregoing discussions the outstanding features and the usefulness of previous systems of classification may be briefly summarized as follows:

1. The system of Körnicke and Werner, based on morphological differences of panicles, spikelets, and grains, is competent for the distinction

of types, but the identification of separate varieties by this system would be tedious, since it is left to the comparison of descriptions.

2. Atterberg's method of bringing together varieties alike in physical properties offers merely a system for the determination of the quality of grains. Groups of varieties thus classified would lose their identity under radical changes of environment. The system fails to group varieties of the same morphological character, and therefore it cannot be used for their identification.

3. The system proposed by Denaiffe and Sirodot is largely based on the relative forms of grains and their absolute measurements and weights, and it lacks efficiency to the extent of its employment of such characters. However, certain morphological characters suggested by these authors are useful both for identification and for description.

4. Nilsson's classes, chiefly described by the form of panicles, are often transitional and lacking in distinctiveness; and hence the group relationship of varieties would often be extremely difficult to determine by this system.

5. Böhmer's system combines the panicle classes of Nilsson with certain grain forms described by Atterberg. Classes arranged by this system would therefore be both transitional and subject to radical changes by the influence of environment.

GENERAL CONSIDERATIONS

To be of practical use, a classification of any group of economic plants must serve a twofold purpose: it must provide a means of identifying the members of the group, and it must standardize varietal nomenclature.

The previous systems of classifying varieties of oats do not fulfill this purpose. Each of them fails as a means of identifying large numbers of varieties, for one or more of the following reasons: (1) a physical basis of construction; (2) a lack of competent and stable distinctions for groups of varieties; (3) a lack of systematic differentiation of groups into individual varieties. As a means of establishing a system of varietal nomenclature these earlier classifications, all of them foreign, are of little use in this country. American and European varieties of similar form are generally differently named, and hence much confusion would attend the adoption in this country of a European standard of nomenclature.

The review and discussion of the work of others has shown that a classification of varieties of oats, in order to be effective, must be based on the morphology of the plant. Accordingly the present classification has proceeded by the following steps: (1) a study of the morphology of the plant in order to discover the various characters by which individual varieties may differ; (2) an analysis of the varieties *en masse*, to reach the types which for the present purpose are considered elemental, that is, types that differ in one or more morphological characteristics; (3) an arrangement of varieties in groups, regardless of nomenclature, according to their likeness to the elemental types that represent the groups. Finally, the groups have been fully described and named, and a key has been constructed for their identification.

The system of naming the groups has consisted merely in applying the name that occurred the most frequently among the specimens of each group. This system, while arbitrary, seems the only logical one, for in many cases there is no means of determining which of several names was carried by the original variety. In all cases, however, the additional different names have been reserved and arranged as synonyms.

CLASSIFICATION MATERIAL

In this study seven hundred and thirty-one specimens, very many of them alike in name, have been classified. By far the largest number of these specimens, or so-called varieties, were brought together in 1909 at the Nebraska Agricultural Experiment Station, by Professor E. G. Montgomery and M. S. Jussell, who began their classification and laid the foundation for the present work. In making the collection, seeds were obtained of all varieties grown by forty experiment stations and of those sold by fifty-three seed houses. The original collection included all varieties then grown or offered for sale in the United States. In 1912 a duplicate collection was sent by the Nebraska station to the Office of Cereal Investigations, United States Department of Agriculture, and in that year the varieties were grown on the government experimental fields at Arlington, Virginia, and also at the Iowa Agricultural Experiment Station, at Ames, Iowa. In the following year, 1913, a duplicate collection was sent by the Office of Cereal Investigations to the Department of Plant Breeding at Cornell University. The varieties were grown in the plant-breeding field during the summer of 1913, at which time they were trans-

ferred to the Department of Farm Crops and came to the hands of the writer, by whom, in cooperation with the Office of Cereal Investigations, the work of classification was continued. During the years 1913, 1914, and 1915, the original collection has been supplemented by accessions from the Office of Cereal Investigations and from various other sources, all of which have supplied many new varieties or old varieties under new names that have appeared in the catalogs of seedsmen or in the reports of experiment stations.

During the time that the collection has been in the hands of the writer, the varieties have each year been grown in rows one rod in length spaced one foot apart. The plants were thinned to spaces of six inches in the row, thus giving equally to each plant a sufficient area in which to develop its growth.

MORPHOLOGY OF THE OATS PLANT

The following discussions present in considerable detail the morphology of the oats plant. The important taxonomic characters are described and their uses in previous classifications and in the present one are explained.

THE CARYOPSIS

In the characteristic spikelet of Avena the lemma and the palea firmly clasp the caryopsis, and the three parts combine to form the oats grain. The caryopsis, or kernel, presents in itself no morphological differences that may be utilized in classification; for it is always more or less spindle-shaped, furrowed on one side, and hairy at the tip and on the sides. The close investment of the kernel by the lemma and the palea, however, is an important character and serves to distinguish all other species of Avena from *Avena nuda*, in which the caryopsis is loose and free within its bracts, the parts readily separating. This characteristic of the *A. nuda* spikelet is considered by all systematists a specific distinction, and it presents the only case in which the caryopsis is directly concerned in the classification of varieties of oats.

BASILAR CONNECTION OF THE GRAINS

Among certain wild types of Avena the peduncle of the spikelet is slightly inserted into the callus of the first grain, and the junction of the two parts forms a well-articulated joint at which they easily separate when mature. The articulation of the second and third grains, however,

varies with the species. In *A. sterilis* and its derivatives, the rhachilla and the callus of the upper grains are confluent, and the grains do not separate from their axes but tear away at its base the rhachilla itself (Plate I, 1, B). Among other forms, however, the rhachilla articulates with the callus of the upper grains approximately in the same manner as does the peduncle with that of the lower grain (Plate I, 2, B).

The characteristic basilar connection of the grains is not equally retained by the cultivated descendants of different wild types. The cultivated forms of *A. sterilis* retain, in this respect, the character of their wild ancestor, the lower grain articulating with its peduncle while the upper grains remain strongly adherent to their rhachillas (Plate II, 1, B). But in forms descended from *A. fatua*, although the upper grains still separate easily from their rhachillas, the articulation of the lower grain has become so solidified that its lines of demarcation are completely obliterated and the grain separates from its peduncle only by a rupture (Plates II, 2, B, and III, 1, B). The character of the basilar connection of their grains thus affords a marked distinction of cultivated *A. sterilis* forms on the one hand and of cultivated *A. fatua* forms (*A. sativa* and *A. sativa orientalis*) on the other. Trabut (1911), in studies of oats of the Mediterranean littoral, has by the use of this character traced a complete series of *A. sterilis*, beginning with the wild and ending with the cultivated forms. Schulz (1913), also, has utilized the character to distinguish *A. sterilis* from *A. fatua*, *A. barbata*, and *A. Wiestii*. Previous to the specific use of the character by Trabut, Norton (1907) had called attention to the firm union of the first and second grains in the spikelet of the cultivated forms of *A. sterilis*; and M. Körnicke (F. Körnicke, 1909) had communicated the result of certain studies by F. Körnicke in which the latter, in describing two cultivated types which he named *Modigenita* and *Quadriflora*, had mentioned the hanging-together of the grains during threshing — an indirect reference to the non-articulation of the upper grains. It may readily be assumed that F. Körnicke's varieties were of the *A. sterilis* form, since the persistence of the upper grains to their rhachillas is limited to that species.

The specific character of the basilar connection of the grains has not previously been utilized in extensive classification of cultivated varieties. Denaiffe and Sirodot (1901) have characterized various forms of grain bases according to the obliquity of the scar produced by removal of the

lower grain from its peduncle, but these authors do not relate the form of the base with the more definite character of articulation or non-articulation. Böhmer (1911) also mentions several forms of grain bases, but does not use them in his classification.

In the present study this character was found of the utmost value for distinguishing the cultivated forms of *A. sterilis* from those of *A. fatua*. The articulation of the lower grain is not so distinct as in the wild type, but the lines of separation may easily be recognized, and these, together with the adherence of the upper grains to their rhachillas, afford a reliable means of identifying *A. sterilis* forms.

HAIRS OF THE GRAIN

The hairs, or bristles, of the grain have been used by many systematists in the classification of cereal varieties. Neergaard (1889), in classifying varieties of barley, uses the hairs at the base of the grain as one of two fundamental variants for the distinction of groups. Other investigators, notably Blaringhem (1904) and Harlan (1914), have supported Neergaard's system. Broili (1906), however, believes the hairs would be inconstant under various environments, and hence not a reliable means of classification. Scofield (1903) includes the length and the color of hairs at the base of the glumes in his descriptions of wheat varieties. Fischer (1900) holds the appearance of hairs in oats as a mark of degeneration, which is more frequently manifest in winter varieties than in others. In the classification and description of varieties of oats by Denaiffe and Sirodot (1901) and by Körnicke and Werner (1885), the hairs of the grain were employed as supplementary marks of distinction. The last-named authors, however, do not state the exact location of the hairs to which they refer, and hence their use of the character is somewhat vague.

In the most precise use of the character as an aid in distinguishing varieties of oats, the hairs of the grain must be classified as (1) hairs of the lemma, (2) hairs of the callus, and (3) hairs of the rhachilla (Plate I, 2, A and B).

Hairs of the lemma

The lemma (also called the flowering scale, flowering glume, inner glume, and superior glume) is the lower of two bracts immediately inclos-

ing the flower in the grasses. In many wild species of Avena the lemma is more or less densely hairy, and the specific character of the hairs themselves is in some cases a mark of distinction. Among cultivated forms, however, the lemma is usually glabrous, and it is only in rare instances that a variety is distinguished by hairs on this part of the grain.

Hairs of the callus

The callus, a somewhat swollen callosity at the base of the lemma, is an insignificant part of the oats grain, but it often bears more or less conspicuous bristles, conveniently called basal hairs, which are in some cases an important feature in the description of varieties and useful in establishing their identity. Indeed, the basal hairs are frequently employed by botanists, notably Hitchcock (1908) and Britton and Brown (1896), in characterizing Avena species. Denaiffe and Sirodot (1901) are the only authors who have specifically named the basal hairs in classifying cultivated forms of Avena; although Böhmer (1911), Broili (1910), and Fruwirth (1907) have mentioned this character in discussing the morphology of the oats grain, and have distinguished the following types of basal hairs on the basis of difference in their form and frequency:

Böhmer

1. Numerous to bushy short bristles.
2. Few short bristles.
3. Numerous long, fine, bushy bristles.
4. Few long, fine bristles.
5. Bristles almost wholly absent.
6. Bristles numerous, irregular, long, and fine
7. Bristles long and fine.

Broili

1. Single short hairs.
2. Many short, bristly hairs.
3. Single long hairs.
4. Many long, bushy hairs.
5. Single twisted and band-like hairs.

Fruwirth

1. Hairs very long and numerous.
2. Hairs very long, but few or scarce.
3. Hairs short, few to many.
4. Hairs short, occurring singly.

The classes of Fruwirth, and those of Broili with the exception of the fifth, which has not been observed in the present work, adequately define

the types that may in some cases be used in identifying varieties. The classes arranged by Böhmer, however, are in some cases too finely differentiated for this purpose.

In the description of all varieties, and occasionally for identifying those within small groups, the classes suggested by Broili and Fruwirth are used in the present classification, according to the following outline:

Basal hairs present.
1. Long.
   a. Few.
   b. Many.
2. Short.
   a. Few.
   b. Many.

Basal hairs absent.

The presence of basal hairs may readily be observed, without magnification, in the mature grain. The hairs are lost in threshing, however, and must be observed in the whole spikelet.

Hairs of the rhachilla

The rhachilla, or pedicel, is the secondary axis of the spikelet. It is a slender stalk borne at the base of the grain and articulating with the callus of the succeeding grain, and it often carries from a few to many short, setaceous hairs. The rhachillas of cultivated varieties of oats have been classified by Broili (1910) into several types according to their form and the frequency of their hairs. Denaiffe and Sirodot (1901), alone of the earlier investigators, have considered the character of the rhachilla in establishing the identity of varieties of oats, and they attach far greater importance to its hairiness than to its form. In the present work the hairs of the rhachilla are often used to distinguish varieties within small groups. They are partly destroyed by threshing, but may readily be observed, by a slight magnification, on the matured grain of the complete spikelet, and among several varieties they afford a reliable supplementary mark of identity.

FORM OF THE RHACHILLA

The rhachilla is variously flat, rounded, or furrowed. Its length, except in the extremely elongated spikelet of *A. nuda*, is usually

between 1.5 and 3.5 millimeters. Broili (1910) has described the following types:

1. Short and outstanding.
2. Long and outstanding.
3. Long and partly inclosed by the lemma.
4. Round for its entire length.
5. Flattened for its entire length.
6. Flattened, and on the upper third laterally furrowed.
7. Flattened and furrowed at the base.
8. Round and hairy.

Denaiffe and Sirodot (1901) characterize the most general forms of the rhachilla, which may used in classification, as follows:

1. 2.5–3 mm. long, round, and toward the apex gradually swelling into a knob-like head.
2. 1.5–2 mm. long, more or less flattened and furrowed, and not swollen at the apex.

Böhmer (1908–09) found, during four years of investigation, that the form and length of the rhachilla remained constant.

In the present study the descriptions of the rhachilla by Broili and by Denaiffe and Sirodot have been found accurate but often extremely difficult to determine; and, moreover, some of the types are not strictly confined to different varieties, but are often combined in the same variety or even in the same panicle. Of the characters of the rhachilla here mentioned, none have been considered worthy of use except hairiness, length, and, in some varieties, the partial envelopment of the rhachilla by the lemma.

NERVES OF THE GLUME AND THE LEMMA

In the species of Avena the venation of the glume and of the lemma appears as slender, rib-like striations. Such veins are called *nerves*, and when in wild forms those of the lemma extend beyond its apex as teeth or awn-points they distinguish the species. Thus, *A. brevis* and *A. strigosa* are characterized by such awn- or tooth-like projections (Plates III, 2, A, and IV, A), while for other species, such as *A. pubescens* and *A. Smithii*, the number or the scabrous character of the nerves is a distinguishing feature. In common cultivated varieties, the lemma is never toothed or awn-pointed, and rarely scabrous, but the number and the prominence of the nerves are variable, and may in some cases be used in classification. Denaiffe and Sirodot (1901), alone of the earlier investigators, frequently mention the prominence of the nerves of the lemma as a minor distinction for varieties within small groups.

In the present classification the number of nerves in the glume and in the lemma, and the prominence of nerves in the latter structure, are used as descriptive terms and sometimes to aid in the identification of varieties. The number of nerves in the glume varies from seven to thirteen, but in most varieties it is usually nine; in the lemma the usual number is seven, although the limits are from five to ten. The prominence of the nerves is a relative character the estimation of which must be left to the judgment of the investigator. The number and the prominence of the nerves are inheritable characters and in a given variety do not vary beyond the characteristic limits. The nerves of the glumes may easily be counted in the green spikelet, while those of the lemma are more distinct in the matured grain.

THE AWN

The awn, or beard, of Avena is an extension of the midrib of the lemma, emerging from the epidermis at about the middle of the grain. In wild forms it thus appears on all grains of the spikelet, and usually is geniculate and, below the knee, twisted (Plate I, 1, A). The form and the persistence of the awn are usually included by botanists in descriptions of Avena species. In most cultivated varieties the awn is carried only by the lower grain, and is usually straight, weak, and scarcely twisted. A few cultivated varieties, however, have awns which are rather strongly twisted and occasionally geniculate. Trabut (1911), in tracing a series of *A. sterilis* between the wild and the cultivated types, observed a gradual reduction in the number of awns per spikelet and in their geniculate and twisted form. Zade (1912), on crossing a cultivated variety with *A. fatua*, found that in hybrids of the first generation the lower grain only of the spikelet was bearded. Nilsson-Ehle (1914) found awns to be produced more numerously by white and black grains than by yellow grains, the latter apparently containing a factor which inhibited their development.

The appearance of numerous strong awns in cultivated oats is regarded by many as a mark of degeneracy resulting from unfavorable conditions for growth. There is not sufficient evidence, however, to prove that such so-called reversions are anything more than intermediate forms which occur in the mixed population of cultivated oats; for, while certain varieties are awnless, many of the best varieties, as Swedish Select, have numerous, rather strong, awns, and frequently in varieties of the *A. sterilis*

group all grains of the spikelet are awned. Roberts and Freeman (1908), on investigating the "degeneracy" of the Texas Red variety, found merely a mixture of two distinct forms.

In systematizing cultivated oats the awn is a character of much taxonomic value. Körnicke and Werner (1885) made the primary division of their principal group according to the number of awns in the spikelet. Thus, varieties with awnless or one-awned spikelets were separated from those with two-awned spikelets; and for the distinction of individual varieties of the former group the presence or the absence of awns was coordinated with the color of grains. Denaiffe and Sirodot (1901) frequently used the presence and the form of awns as secondary characters for the distinction of groups. With respect to awns, they divided the grains into three groups: (1) awnless; (2) outer grains with coarse, deciduous awns; (3) outer grains with finer, persistent awns. Atterberg (1891), Nilsson (1901), and Böhmer (1911) made no use of the awns in classification, although Böhmer (1908–09) believed that varieties might be grouped according to the classes of Denaiffe and Sirodot, even though their group relationship would often be uncertain. Broili (1910) believes the awn to have little or no systematic value.

In the present classification the presence or the absence of awns has been regarded as a character of secondary importance and frequently used in that order. Geniculate awns appear often only in a few half-wild varieties, but in such cases they are recognized as a distinguishing character. No statistical studies have herein been made of the inheritance in frequency of awns, but in respect to the actual presence or absence of awns, together with their form, the varieties under study have by observation remained constant.

FORM OF THE GRAIN

A differentiation of the form of grains, including plumpness, or fullness, size, and specific outline, has been a prominent feature of most of the previous systems of classification. Atterberg (1891) based his classification mainly on the size (weight) of the grains, and on the following shapes: pointed, short, barley-like, and full, or plump. Denaiffe and Sirodot (1901) incorporated in their system the method of Atterberg, and in addition employed other shapes of the grain, described as slender and duckbill. Nilsson (1901) and Böhmer (1911) made the form of the grains subordinate to the character of the panicle; and the latter author,

while employing certain of the classes suggested by Atterberg, referred also to the points of the grain and to its ventral groove.

In the present studies the form of the grain, considered with reference to any or all of its characteristics mentioned above, has been found to exhibit a marked transitional tendency; and therefore, in attempting to organize into groups a large number of varieties on the basis of differences in their grain forms, one soon meets with difficulty in determining the group relationship of particular varieties. The characteristics of form are also very difficult to describe. Thus, certain forms are not accurately defined by the terms *plump* and *long-pointed*; only the relative conditions are stated, and the distinction is left to the judgment of the person using the classification.

Being, then, a transitional character and a relative one, the form of the grain can have only a very limited use in classification. It has been used occasionally in the present work to divide small groups reduced to as few members as possible by previous separations on the basis of more sharply defined taxonomic differences.

COLOR OF THE GRAIN

The color of the grain, or, more definitely, the color of the lemma when ripe, has been accorded various degrees of importance in classification by other investigators. Körnicke and Werner (1885) used color alone to distinguish the main groups of varieties in *A. sativa* and *A. sativa orientalis*. Nilsson (1901), in arranging the Svalöf system, made the color of the grains and the coordinating form of panicles the main distinction for principal types. Denaiffe and Sirodot (1901) characterized main groups of varieties by stating the range in their color; and to describe single varieties they made numerous fine subdivisions of color within each group. Dufour and Dassonville (1903) believe that color is one of the most important characters for the differentiation of groups, but that it must be considered *en masse* rather than in individual grains. Böhmer (1908–09) used color only as a final means of distinguishing varieties within groups characterized by the form of panicles, spikelets, and grains. Fruwirth (1907), also, believes color to be of little importance in classification. Atterberg (1891) mentions it only as a descriptive character.

In the present classification color is in some cases made the basis for the separation of principal groups. It is the most conspicuous character

of the oats grain; it is with certainty inherited; and therefore it is of particular use in identification and description. To be sure, the color of a given variety is not absolutely stable, for under changes of environment it may pass into different tones of the same general hue, which, however, do not transgress the limits of the type. Nilsson-Ehle (1909) has reported the constancy of color inheritance in oats grains, although noting a slight variation under changes of environment — due, he believes, to the influence of the soil. He finds the range in variation of dark-colored forms to be only from brown to black, and the reverse. Denaiffe and Sirodot (1901) also found color to be accurately inherited; but by the influence of environment, they said, black grains shade toward gray but never toward red, while brown grains shade toward red but not toward gray. Böhmer's investigation (1908–09) of dark-colored varieties gave results similar to those of Denaiffe and Sirodot; and in studying yellow varieties also, he found these to shade into various tones of yellow but never into white. Zade (1912), in noting the inheritance of characters in *A. fatua*, found the colors of the grain accurately reproduced.

It appears, then, that the basic types of color in grains are not transitional, but merely variable within certain limits; therefore it is only necessary to differentiate the colors properly in order to use them as means of distinguishing varieties. In doing this, however, one must not attempt to make fine subdivisions of color, for the distinction may be lost by variation within the type. The following classifications of color are given to illustrate the use of the character by different authors:

Zade (*A. fatua*)

Brown or black.
Gray.
White.

Körnicke and Werner (various species)

White.
Yellow.
Gray.
Brown or red.
Black.

Nilsson (*A. sativa* and *A. sativa orientalis*)

Light, Dark } Many fine subdivisions in color between varieties of each class.

Böhmer (*A. sativa* and *A. sativa orientalis*)
Light-colored:
White, white-yellowish.
Yellowish, yellow.
Dark-colored:
Black, brown, red, gray.

Denaiffe and Sirodot (*A. sativa* and *A. sativa orientalis*)
Light-colored:
White, white-yellowish, yellow.
Dark-colored:
Black, red, gray.

In the present classification, several large groups of varieties are primarily divided, with respect to color, merely as dark-colored (black, brown, red, gray) and light-colored (white, yellow), but further division on the basis of color is made only in groups that have been reduced by separations according to differences in other characters. This apparent reluctance to make immediate further separation on the basis of color is not due to lack of faith in the stability of the character, but merely because, for convenience in classification, the use of other characters is expedient. In three years of investigation the colors of grains have been found constant within the limits of the classes outlined in this paragraph. With respect to variability of color types, the observation may be added that from year to year unlike weather conditions at the time of ripening will cause slight variations in the color of a given variety. Thus, if the maturing period is during bright, dry weather, the grains are brighter and more pronounced in color than if the maturing period is during wet and cloudy weather. Black or yellow grains that ripen under the latter atmospheric conditions show a tendency toward smoky brown and pale yellow, although never becoming reddish brown or white. The stage of maturity at which the grain is harvested also affects its shade of color, all colors being more pronounced when the grain is thoroughly matured than when it is either slightly immature or allowed to weather after the maturation period has passed.

DIMENSIONS OF THE GRAINS

Although Denaiffe and Sirodot (1901) minutely characterized the grains by absolute measurements and often used the same feature to distinguish secondary groups of varieties, other investigators, while including the dimensions of grains in the detailed descriptions of varieties,

have not used them for the differentiation of classes. In the present classification the dimensions of grains are seldom used for any but a descriptive purpose. There are very few varieties the grains of which may distinctly be characterized by dimensions. In nearly all varieties the measurements of grains cannot be classified; they are transitional between types and between individual varieties.

DOUBLE-GRAINS

The so-called "double-grain" in cultivated oats is a condition of the spikelet in which the second grain is either partly or wholly inclosed by the lemma of the defective first grain (Plate XXI, 3). It is found only in spikelets that have two grains, and has been considered by other writers both as a mere abnormality and as a varietal characteristic. Atterberg (1891) believed double-grains to be due to unfavorable conditions of weather at the time of ripening, and therefore of no importance in classification; but he also noted their more numerous occurrence in certain varieties than in others. Fruwirth (1907) speaks of normally developed double-grains, and observed a varietal tendency to produce them. Nilsson-Ehle (1906) apparently regarded double-grains as a character of little importance in oat breeding, since under the environmental conditions existing in Sweden they composed but a small proportion of the total number of grains in the panicle. He found, however, among different varieties a decided range in the occurrence of double-grains, in respect of which there was a varietal stability under somewhat different environments. The investigation of Böhmer (1908–09) shows a greater tendency by some varieties than by others to produce double-grains, but the variation in their production was greater as between seasons than as between varieties. Krogmann's data (1908) show a considerable range among varieties with respect to the kernel content of double-grains.

From the foregoing views the status of the double-grained spikelet may be defined as an abnormality resulting from incomplete development, but toward which there is a varietal tendency. This conclusion has been fully confirmed in the present work, but in the production of double-grains a varietal tendency much greater than that reported by others has been observed. For example, in the widely different varieties Storm King and Canadian, the typical spikelet is double-grained, although the data of Nilsson-Ehle and those of Böhmer show, in varieties of Swedish and

German oats, proportions of double-grains ranging only from 0.3 to 4.4 per cent of the total number of grains. The value of double-grains as a character in classification is therefore only local, and their occurrence in certain varieties may in most cases be considered a measure of the lack of adaptability of the variety to its environment. However, since the limits of environment under which double-grains predominate in certain varieties cannot be stated, they must in such cases be accepted as a varietal characteristic, subject, perhaps, to place variation. On that basis they are used in the present classification as a supplementary character for the identification of the few varieties in which, under this environment, they form the typical predominating spikelet.

Double-grains may readily be identified when mature. Many observers, however, have apparently mistaken double-grains for the very unusual single-grained spikelet. One rarely finds a so-called single-grained spikelet which on examination does not prove to be really a double-grain with the first or the second grain, or both, defective or rudimentary.

THE SPIKELET

Without considering separately its parts, the spikelet as a morphologic entity presents only two characters useful in classification, namely, its attitude and the number of grains it carries.

Attitude of spikelets

In different varieties the attitude of the spikelets may be observed as pendant, pectinate, and confused (pointing in all directions) (figs. 12, 13, and 14, respectively). All these forms are found among varieties of *A. sativa orientalis* and they are in some cases useful in classifying the members of that group. In all other varieties, however, only the pendant form is found, and hence no distinction by the attitude of spikelets is to be made outside of the *A. sativa orientalis* group.

Number of grains in spikelet

In the common cultivated forms of oats the number of grains carried by the spikelet ranges from one to three, with the exception of *A. nuda*, the spikelets of which often bear four, five, or even six grains. There are no varieties bearing exclusively one-, two-, or three-grained spikelets,

Fig. 12. panicle form of avena sterilis and avena fatua, showing pendant attitude of spikelets

and any distinction by this character must be according only to the prevailing number of grains. In all previous classifications the prevailing number of grains in the spikelet has been given greater or less prominence in the characterization of groups. Atterberg (1891) distinguished three main groups of his system by this means. Other investigators, however, have made less use of the character, employing it as a supplementary distinction or only in special cases.

Fig. 13. Panicle of Avena sativa orientalis, showing pectinate attitude of spikelets

The chief objection to the use in classification of the number of grains in the spikelet is because of the uncertain definition of one-, two-, or three-grained spikelets. Shall the definition be based on the number of fully developed grains, or shall it include defective grains? Thus there is no definite point at which fully developed two-grained spikelets can be separated as a class from those of the defective double-grained

Fig. 14. Panicle of Avena sativa orientalis, showing confused attitude of spikelets

type; nor can the latter be segregated as a class from so-called one-grained spikelets, which in reality are nothing less than extreme cases of double-grained spikelets. And, could such distinctions be established, there is no assurance that the classes thus arranged would remain constant under a change of environment. Bünger (1906) has found the number of spikelets per panicle to vary greatly with the moisture content of the soil, and there is no reason to believe that the number of grains per spikelet would not vary also.

In the present classification the number of grains in the spikelet is used only in a few special cases, when as between individual varieties of a small group there is a marked difference in respect to this character. In the detailed descriptions of varieties the prevailing number of grains is mentioned merely as a record for this environment.

MATURING PERIOD

The maturing period, an important factor of the economic value of varieties, has a very limited use in classification. Varieties may be spoken of as *early* or *late* only in a relative sense, and not as actually defining a characteristic by which they may be identified. There is mutability of maturation in response to different climates and different soil conditions; and while for each variety there are also limits beyond which its ripening period does not fluctuate, these cannot at present be accurately established. The data from comparative tests of varieties under different environments, by which a range in ripening periods might be fixed, are unfortunately often rendered untrustworthy by the confusion of varietal nomenclature. In this classification the writer is therefore limited to statements of the ripening periods of varieties only as applying to the present environment; such statements as a rule being for the most general purpose of description, although for the extremely early varieties Sixty-Day and Kherson the time required for ripening is used as a supplementary means of distinction.

COLOR OF GLUMES AT MATURITY

The color of the ripened glume differs but little in cultivated varieties. Nilsson (1901) has distinguished pale golden from a deeper, brighter tone of the same color, and he uses the two shades of color in the description of single varieties. Körnicke and Werner (1885) often employed the

character for the same purpose, but Fruwirth (1907) considers it of no value. While under given conditions a distinction in the color of the glume may be observed, the difference is slight and is largely dependent on the stage of ripening at which the observation is made and on the climatic environment; therefore the character is an inconstant one and is not worthy of use in classification.

PHYSICAL PROPERTIES OF GRAINS

Although the absolute weight of the grains, and their proportion of kernel and hull, were used in classification by Atterberg (1891) and by Denaiffe and Sirodot (1901), no other investigators have employed these characters for the separation of a large number of varieties. Böhmer (1908–09) argues that the physical properties are too easily influenced by conditions of climate and soil to be reliable characters in classification. His extensive data show not only that in the weight of grains there was from year to year a greater difference than was covered by the classes of Atterberg and the French authors, but also that in a given year the position of the grain in the spikelet would determine its group relationship in weight and kernel content. Thus, in respect to these characters, outer grains would fall into higher classes than inner or middle grains. There is an abundance of other data to support Böhmer's conclusions. Fruwirth (1907) shows the same wide difference between outer and inner grains in weight and in proportion of kernel, and he also finds that both properties are influenced by the position of the grains in the panicle; grains borne by the upper branches are heavier and richer in kernels than those borne by the lower branches, on which there are a greater number of sterile flowers. Lippoldes (1904) shows further a difference between the weight of grains from various stems of the same stool.

As to the effect of soil and moisture on the physical properties of the grains, Bünger (1906) found that poor soils, low in moisture, produced light grains, small kernels, and many sterile spikelets. The effect of an extreme range in seasons on the weight and the kernel content of the oats grain has been shown by Seton (1903), Edler (1905), and Berry (1912), all of whom found that much larger and plumper grains were produced in cool, moist seasons than in hot, dry seasons. Berry, who classified the grains of oats into several types on the basis of physical properties, believed that the distinction between his classes might be greatly modified,

or even obliterated, by a radical change in climatic environment. The conclusions of Jensen (1899) would seem to provide a basis for Berry's conclusion, for Jensen, on collecting varieties of oats from many countries, found that by far the heaviest grains came from countries having an insular or a coast climate.

In view of the many factors influencing them, the physical properties of grains are of no use in any classification beyond a mere arrangement of market grades. Classes based on such characters could not be expected to remain constant under the extremely wide range of climatic environment in this country. And even under given conditions of environment, the variation in weight and in kernel content, according to the position of the grain in the spikelet and in the panicle, would make difficult an accurate arrangement of types.

THE PANICLE

The panicle, or loose flowering head, exhibits among the wild forms of Avena no distinct taxonomic differences. Botanists mention the length and the form of the panicle as a general descriptive feature but not as a specific distinction. Among cultivated varieties, however, two characters of the panicles may be directly utilized in classification. These are its form, and certain peculiarities in the structure of its rhachis.

Form of the panicle

The form of the panicle is determined by the attitude of the branches. These may form the common, roughly equilateral panicle, as in *A. sativa* (fig. 24, page 136), or the unilateral panicle of *A. sativa orientalis* (fig. 13, page 111), or any variation of these types. In both the contrasting types the branches issue from various sides of the rhachis, but later assume different attitudes. The branches of the equilateral panicle spread outward from various sides of the rhachis and extend upward at an angle of about forty-five degrees, and, shortening toward the apex, form a rough pyramid. Panicles of this type may be compact and stiff, with each branch in an ascendant attitude along the line of its initial angle for its entire length; or they may be open and lax, with the branches ascendant but finally drooping from the middle outward. In unilateral panicles the branches incline from one side of the rhachis, and, extending upward

at an acute angle, are somewhat appressed, often being in contact with the rhachis itself. Varieties with such unilateral panicles are commonly termed *side*, *flag*, *banner*, or *horsemane* oats.

As between the unilateral and equilateral types, the whorls of branches are not different in number; nor is there in this respect any varietal distinction within each type, the number of whorls commonly varying from five to eight in each variety. Thus the relative compactness of the panicles of different varieties depends on the attitude and the number of the branches and the length of the internodes, but not on the actual number of whorls of branches. The apex of the panicle differs slightly among varieties of each type. In some varieties it is straight, erect, and short; in others it is longer, somewhat tenuous, and drooping. The difference, however, is not well marked, and the two forms are often transitional in the same variety.

The form of the panicle has been used in all previous systems of classification, except that of Atterburg. Nilsson (1901) found among the varieties at Svalöf the following types:

1. Stiff panicles.
2. Hanging panicles.
3. Bushy panicles.
4. Loose panicles.
5. Side panicles.

These were coordinated with light- and dark-colored grains to distinguish ten main groups of varieties. Böhmer (1908–09) adopted the panicle types employed by Nilsson, and, with modifications in their description, used them as the chief distinction of his main classes. Körnicke and Werner (1885) made a distinction only between the unilateral and equilateral types of panicles, while Denaiffe and Sirodot (1901) used the form of panicles only as a descriptive feature and not as a means of separating the groups of varieties.

As may be seen from the descriptions of the panicle types of Nilsson and of Böhmer (1908–09 : 12–15), these authors made several subdivisions of the equilateral, or spreading, form, according to the elongation of the rhachis and the angle at which the branches depended from their axes. Ulander (1906), Fruwirth (1907), and Broili (1910) have all mentioned these types, and Broili has illustrated them, thus indicating their appearance in almost any large collection of varieties. And indeed

the types are not uncommon, for all of them have been recognized among the varieties of the present classification. But the establishment of groups of varieties according to such fine subdivisions in the form of panicles was found to be exceedingly difficult and impracticable. There is a clear and constant distinction between the unilateral and equilateral forms, but subdivisions of either form, while well defined between certain varieties, are transitional between others. In fact, often the panicles of the same plant were found to exhibit a transition between certain forms described by Nilsson and by Böhmer. It would not be possible, therefore, to establish accurately the group relationship of a large number of varieties in a system based on fine distinctions between forms of the panicles. There would be uncertainty in many cases as to which of two transitional groups should include a given variety.

In the present classification the *A. sativa orientalis* group is distinguished by its unilateral panicles, and there is no probability of confusing the one-sided, appressed panicles of this group with the equilateral, spreading panicles of other groups. Beyond this primary distinction, however, the form of panicles is employed in but few cases, and then only as a supplementary character for the separation of smaller groups.

The rhachis

The rhachis, which is that part of the stem running through the panicle, commonly shows among the forms of Avena no taxonomic differences. It is usually slightly flexuous, and uniform throughout its length. In marked contrast to this general form, however, there are a few varieties, mostly of the *A. sativa orientalis* group, in which the rhachis exhibits two peculiarities of structure — an extremely flexuous form, and an abnormal node at the point from which arises the lowest whorl of branches (fig. 15, A). The peculiar node is very striking. It is situated at a somewhat geniculate bend in the rhachis, and its diaphragm is usually wanting. Lacking a nodal diaphragm, the stem is hollow at this point in contrast to its solidity at normal nodes (fig. 15, B). Below the geniculate bend is a normal, although branchless and leafless, node, and the two nodes, although in some cases fused, are usually from one to four inches apart. The branches probably originate at the outlying normal

node, but fuse with the stem until finally they issue from the knee-like bend, which thus becomes nominally the first node of the panicle. The diaphragm of the first node is usually, but not always, absent. In some cases, when the first node, or bend, is fused with the outlying node, the diaphragm is present, although often more or less defective; but in such cases the diaphragm thus appearing is doubtless a part of the usual outlying node.

Without special histological studies of its structure, little can be said of this peculiarity of the rhachis, although for its present taxonomic use the foregoing general description is sufficient. Neither the abnormal node nor the extremely flexuous form of the rhachis has been used in previous classifications of varieties of oats, although Denaiffe and Sirodot (1901) have described and illustrated the former. For a few varieties of the present classification, however, these exceptional characters provide a marked distinction, and for that purpose they are used.

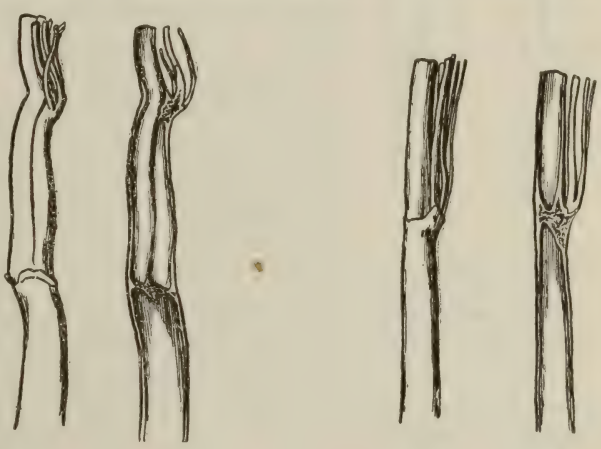

Fig. 15. The abnormal node in certain varieties of Avena sativa orientalis

A, Section of stem and rhachis showing the lowest whorl of branches issuing from a bend in the rhachis at which the nodal diaphragm is wanting, while the true node, branchless, lies some distance below; B, section of stem and rhachis showing the lowest whorl of branches arising from a normal node at which the nodal diaphragm is well developed.

The Leaves

In the leaves of cultivated oats the varietal differences are found in their margins and dimensions. Körnicke and Werner (1885), in describing varieties, mentioned the ciliate margins and the length and width of leaves, but they did not use these characters in classification. Among certain groups of varieties, however, the leaves differ greatly. Thus there is a marked distinction between the fine, narrow leaves of Sixty-Day and Kherson, and the wide, coarse leaves of Storm King and Sparrow-

bill, although between varieties of a similar type the leaves are scarcely unlike. The varietal difference in size of the leaves is better expressed in width than in length, for the latter dimension is the less constant in a given variety and, because of the drying and breaking of the tips, is often difficult to ascertain correctly. However, the dimensions of the leaves are not here used in classification, but merely as a minor character in description. The only important character of the leaf used in this classification is the presence or the absence of its cilia, or marginal hairs (fig. 16). The cilia, when present, are to be found on the margins of all leaves below the uppermost one, and they are a definite, inherited, and easily observed morphological character, sometimes useful in distinguishing varieties. They are best observed in the green plant, for when at maturity the leaves become shriveled the cilia are obscure.

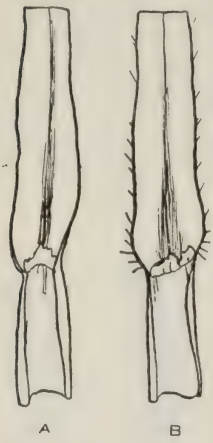

FIG. 16. SECTIONS OF OATS LEAF SHOWING (A) GLABROUS MARGINS AND (B) CILIATE MARGINS

THE LIGULE AND THE AURICLE

The ligule, a scarious, cartilaginous appendage borne at the orifice of the sheath, is characteristic of the Gramineae and is rarely wanting (fig. 17). Indeed the ligule is such a fixed and definite morphological character of the grass family that its structural variation and its absolute length are frequently used by botanists as a feature in the characterization of separate species. Within species of the Gramineae, the absence of the ligule is so distinctly unusual that it is of remarkable value for fixing the identity of a single variety or of a group of varieties.

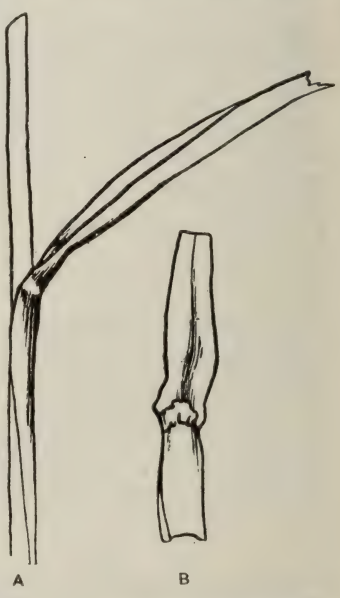

FIG. 17. A NORMAL LIGULATE AND AURICULATE LEAF

A, Leaf bending away from the stem at its junction with the sheath; B, section of leaf showing on the inner side the ligule

There are but few cases reported in which members of the Gramineae have been found to lack this character. The writer has observed it to be wanting in *Echinochloa crusgalli* var. *muticum*, *E. Walteri*, and *E. frumentacea*. Emerson (1912) discovered a type of dent corn (*Zea mays indentata*) which lacked not only the ligule but also the auricle. He found that the progeny of self-pollinated plants of this type inherited with certainty the non-ligulate and non-auriculate character of the parent, and that in crosses with normal plants the peculiar character segregated as a recessive one in hybrids of the second generation. From a description and illustration by Collins (1909) it would appear also that in plants of a certain type of *Zea mays* from China the ligule and the auricle were absent, or at least rudimentary. Nilsson-Ehle (1909) reported the absence of the ligule in the variety Jaune Géant à Grappes of *A. sativa orientalis*, and he, like Emerson, found the character to be strictly inheritable and to act as a recessive one in the second-generation hybrids. In the same species, Schneider (1912) noted the non-ligulate character of the varieties Golden Giant and Giant Banner, although he made no studies of its transmission.

In the present studies the absence of the ligule and the auricle has been observed only in certain varieties of *A. sativa orientalis*, two of which correspond to the varieties reported by Nilsson-Ehle and by Schneider. In all these varieties the leaf is approximately continuous in structure with the sheath and its characteristic form may easily be recognized. Unlike the ordinary leaf, it does not bend away from the stem at its junction with the

Fig. 18. An abnormal non-ligulate and non-auriculate leaf

A, Showing how the leaf lies close to the stem for most of its length; B, section of the leaf and sheath, showing on the inner side the non-ligulate character

sheath, but extends upward, and for a part of its length it is nearly parallel with the stem (fig. 18).

The non-ligulate and non-auriculate character of the leaves is a remarkable distinction for certain varieties of *A. sativa orientalis*, and is used in the present classification to separate such varieties from those of the same group having the common ligulate and auriculate leaf. The character has not previously been used in the classification of varieties of oats.

THE SHEATH

The sheath, or lower tubular part of the leaf which envelops the culm, offers few characteristic differences that may be used in classification. The differences are only in relative length and color; and, since the latter is subsequently discussed in relation to the color of the young plant, the only difference to be considered is in length.

With respect to its length the sheath may be divided into two classes — those that partly cover, and those that completely cover, the internodes. Sheaths of the latter type are found only in varieties the leaves of which have no ligule nor auricle. In such varieties the sheath passes without apparent interruption into the leaf, and the continuous structure lies close to the stem to a point some distance above the node. Since in this case the greater length of the sheath is distinctly correlated with the more definite non-ligulate and non-auriculate character of the leaf, it is not in itself considered a specific character and is therefore not worthy of especial use in classification or description.

THE CULM

The culm, or stem, has not previously been used in classification except with respect to its quality, that is, its relative hardness and stiffness. Nilsson (1901) and Böhmer (1908–09), in characterizing groups of varieties, mention the quality of the culms but do not refer to their height and their number per plant. On the other hand, Körnicke and Werner (1885) mention the latter two characters in describing individual varieties, but do not use them in classification. The value in classification of the height, the number, and the quality of culms is very doubtful; for these characters are largely influenced by conditions of growth, and they fluctuate within a wide varietal latitude. Quality and height are also purely relative characters which can be judged only by comparison among many

varieties; and, while they may be used in general description, such characters are not in themselves a reliable means of distinction.

Pubescence at the Nodes

Another character of the culm having a minor descriptive value is the pubescence slightly above and below the nodes. This differs among varieties, but not sufficiently to warrant an important use in classification (fig. 19).

The Roots

There are no varietal differences of roots that may be used in classification. Schneider (1912), from studies of the vegetative characters of oats, believes the ratio of the root mass to that of the parts above ground is a varietal characteristic and is constant under different environments; but his plants were grown in pots, and hence were not exposed to extreme conditions. Bünger (1906), on the other hand, found under field conditions that the mass ratios of all parts of the oats plant were directly related to soil fertility and soil moisture. In the present study no structural differences have been found among the roots of different varieties, and, although often there were marked differences in root mass, such differences were found also within the same variety, being merely an expression of a more vigorous growth.

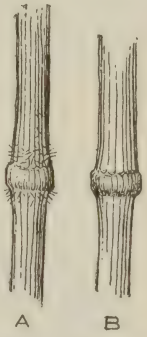

Fig. 19. Sections of oats stem showing (A) stems hairy at the nodes and (B) stems glabrous at the nodes

Habit of Plant in Early Growth

The habit of the culms in early growth is one of the most important characters of the oats plant. It has not been considered by previous investigators, probably because the varieties classified displayed only the common erect habit. Among varieties of the present classification, however, there are three distinct forms in early growth — spreading, semi-spreading, and erect (fig. 20). The young plants of the first type are prostrate in early growth and send out spreading tillers, which later become erect from a somewhat decumbent base. Those of the semi-spreading type are less prostrate than those of the spreading type, and between the time of shooting and that of heading their tillers slant rather than

spread. The third type is erect in early stages and the tillers develop from an upright base.

In later stages even at maturity, plants of the first type may readily be distinguished from those of the second and third types by the somewhat decumbent character of the base. The distinction at later stages between the semi-spreading and erect types is somewhat difficult and can be determined only by a careful comparison of their bases, which differ only in the greater angle at which the culms of the former type bend away from the root crown. The observation of the habit of growth should not, however, be made at such late stages, but at, or shortly after, the

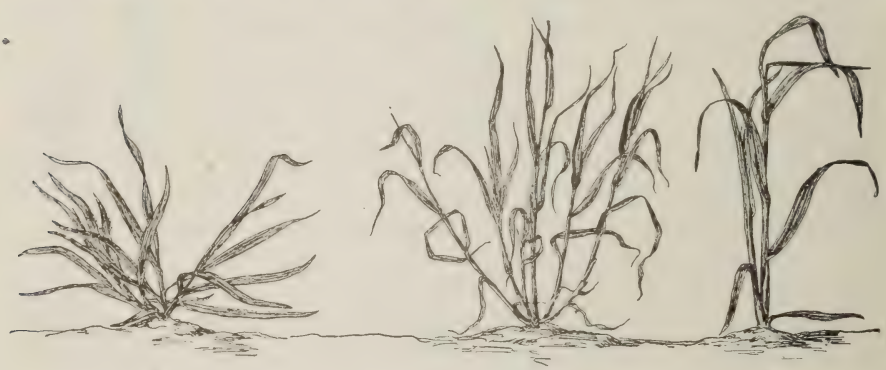

FIG. 20. HABITS OF EARLY GROWTH
A, Spreading; B, semi-spreading; C, erect

period of tillering, or shooting. At this time the differences are very marked and readily ascertained, and they afford a reliable distinction for groups of varieties.

COLOR OF YOUNG PLANT

Although Denaiffe and Sirodot (1901), and Körnicke and Werner (1885), included in their descriptions of varieties the color of the young plants, they did not use the differences in color as a means of classification, nor did they differentiate the color of sheath and leaves from that of the glumes.

When the plants are young there are but few distinct types of color among varieties of oats; and because of the difficulty of correctly defining

it under field conditions, the color of the young plant is of but minor importance in the classification of varieties, being generally useful only in their description. In the present work the color of the plant is employed as a supplementary character for identification only in the case of the variety Canadian, which exhibits at the time of full heading a distinct pale green color of sheaths, leaves, and glumes.

As a feature of the general descriptions of varieties included in the present classification, the following color types have been observed: (1) Leaves dark green, slightly glaucous; sheaths dark green, very glaucous, their general appearance being grayish green; glumes medium green, slightly glaucous. (Plate V.) (2) Leaves light green, often streaked and not uniform in color; sheaths medium green, glaucous; glumes bright green, barely glaucous. (Plate VI.)

Before recording observations of color, it is necessary first to learn by careful inspection the different color types in the general mass; then, by selecting representative plants of each color type, the corresponding color of a given variety may be determined by comparison. In order to define color correctly the observation must be made during a calm, bright period, for in wind and shifting light accurate judgment of color is extremely difficult. It is also essential that colors should be always determined at a definite stage in the growth of the plant. Perhaps they may most accurately be judged at the time of full heading, that is, when the panicle has completely emerged from its sheath. An estimation of color at other periods of development will give different values: if earlier than the time of full heading, the *bloom*, a grayish covering of sheaths, leaves, and glumes, will not have fully developed and the color will be brighter; at a later time, the green color of all parts is being reduced as maturity approaches.

SUMMARY

In the classification of varieties of oats, the following characters are available for the distinction of main groups, or species, for the differentiation of subgroups, and for the identification and description of varieties:

To distinguish *A. nuda* from *A. sterilis*, *A. fatua*, *A. brevis*, *A. strigosa*, *A. sativa*, and *A. sativa orientalis*.

a. The free, or naked, caryopsis.

To distinguish *A. sterilis* from the remaining species.

b. The persistence of the upper grains to their rhachillas.

To distinguish *A. fatua* from the remaining species.
c. The distinct articulation between the grains and their axes.
To distinguish *A. brevis* and *A. strigosa* from *A. sativa* and *A. sativa orientalis.*
d. The awn points or teeth of the lemma.
To distinguish *A. sativa orientalis* from *A. sativa.*
e. The unilateral panicle.
To classify varieties of all groups.
f. 1. Habit of early growth.
2. Color of grains.
3. Ligule and auricle — present or absent.
4. Awns — present or absent, and their character if present.
5. Hairs of callus (basal hairs) — present or absent, and their character if present.
6. Hairs of lemma — present or absent.
7. Hairs of rhachilla — present or absent, and their character if present.
8. Rhachis — form and nodes.
9. Cilia of leaves — present or absent.
10. Nerves of lemma — number and character.
11. Color of immature plant.
12. Spikelets — attitude and number of grains.
13. Form and length of grains.
14. Panicles — form.
15. Culms — relative size.
16. Double-grains.
17. Relative maturing period.

In addition to the above characters, the following may be employed in general description:

1. Dimensions of panicles.
2. Dimensions of leaves.
3. Quality of culms.
4. Height of plants.
5. Relative length of sheath.

Physical properties of the grains, such as weight and proportion of kernel to hull, are too easily influenced by environment to be reliable in classification.

The characters employed for the complete differentiation of each of the main specific groups — *A. sterilis*, *A. sativa*, and *A. sativa orientalis* — are not used in regular order, but according to expediency in classification. Thus the color of grains may be the chief distinction of subgroups, or it may be merely a supplementary character in the identity of small sections or single varieties; and other characters are often transposed in a similar manner. Such irregularity in the use of characters seems justified, however, in a classification which, like the present one, is artificial within the specific groups. A classification of the cultivated varieties of any crop could proceed but little beyond the arrangement of a few main groups if it were limited to a strictly logical and systematic use of charac-

ters; for most characters of cultivated plants have become more or less modified under cultivation, and many of them, although distinct in wild forms, no longer afford reliable marks of identity for cultivated varieties. They cannot be traced through the complexity of cultivated forms; their distinctiveness gradually disappears under the ameliorative influence of cultivation, and is at times inhibited by the presence of factors introduced through hybridization. Hence, with the exception of a few specific differences, the characters available for classification of the varieties of any crop are more or less transitional, and few of them are alone sufficient to establish the identity of a given variety. Therefore the sum of many slight differences must be employed, and by such accumulation the small subgroups, and finally the individuals, may be distinguished.

CLASSIFICATION OF GROUPS

The principal cultivated varieties of oats, together with their basic wild species, may be classified as eight more or less distinct groups, according to the following outline:

PAGE

A. Kernel loose within the surrounding hull; lemma and glumes alike in texture..... *Avena nuda.* 125

AA. Kernel firmly clasped by the hull; lemma and glumes different in texture.

B. Upper grains persistent to their rhachillas..... *Avena sterilis.* 126

BB. Upper grains easily separating from their rhachillas.

C. Lemma extended as teeth or awn points.

D. Lemma with 4 teeth or awn points..... *Avena abyssinica.* 130

DD. Lemma with 2 teeth or awn points.

E. Lemma elongate, lanceolate, with distinct awn points..... *Avena strigosa.* 130

EE. Lemma short, abrupt, blunt, rather toothed than awn-pointed..... *Avena brevis.* 130

CC. Lemma without teeth or awn points.

D. Basilar connections of the grains articulate..... *Avena fatua.* 131

DD. Basilar connections of the grains solidified.

E. Panicles roughly equilateral, spreading..... *Avena sativa.* 132

EE. Panicles unilateral, appressed..... *Avena sativa orientalis.* 154

AVENA NUDA

Avena nuda differs from all other species of Avena by three remarkable characters: (1) the lemma and the palea do not clasp the kernel as in other forms, and the kernel is therefore loose, or free, within the hull; (2) the rhachillas of the three- to many-grained spikelet are so elongate that the uppermost grains are borne above the glumes; and (3) the glumes

and the lemmas are similar in texture. Körnicke and Werner (1885) distinguished five types of *A. nuda*, according to the form of the panicles (unilateral or equilateral), the number of awns in the spikelet, and the color of the kernels. The present classification, however, does not include specimens exhibiting all the variations described by Körnicke and Werner, since only the equilateral form of panicle is represented. (Plate VII, and fig. 21.)

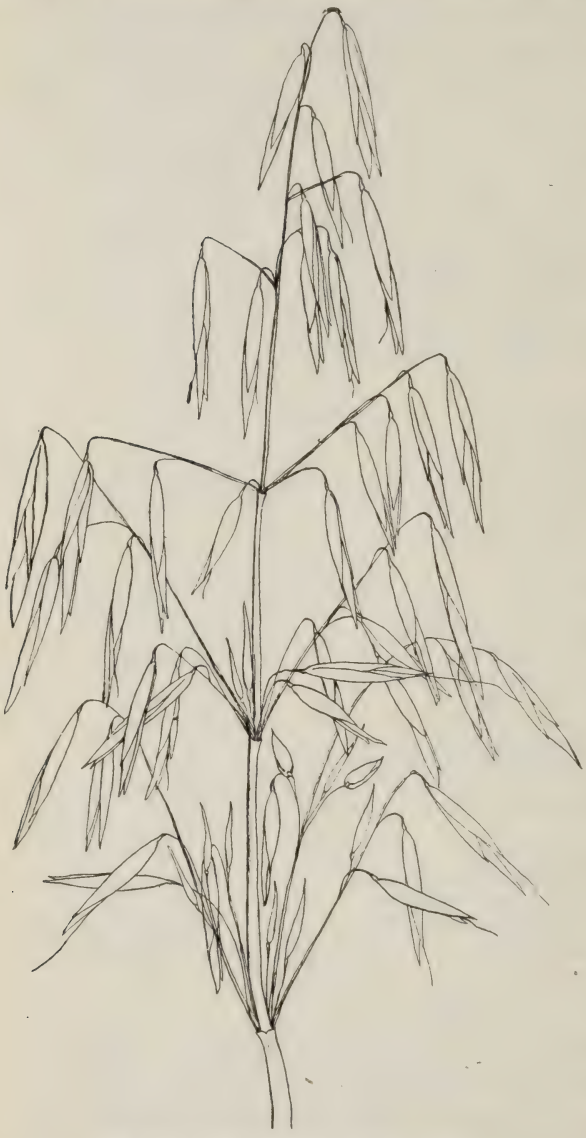

FIG 21. PANICLE OF AVENA NUDA

At the present time *A. nuda* is of no importance as a cultivated plant in either Europe or America, although it is used in China, where according to Schulz (1913) at least one form has been grown for more than a thousand years.

AVENA STERILIS

The wild forms of *Avena sterilis* are distinguished chiefly by the persistence of the upper grains to their axes. The two parts do not easily separate, as in other forms of Avena, and the grain on being removed from the spikelet carries with it its axis,

or rhachilla, itself (Plate I, 1). The basilar connection of the lower grain, however, is like that of other wild forms, such as *A. fatua.*

Cultivated varieties of *A. sterilis* retain to a marked extent the character of the basilar connections of the wild forms. Their upper grains do not separate from their rhachillas, while between the lower grain and its peduncle the lines of articulation are still evident. Another distinction of cultivated *A. sterilis* forms is the elongated caryopsis, this being of greater length than in most other varieties. (Plate II, 1, and fig. 12.)

The cultivated forms of *A. sterilis* are widely distributed. They are the principal oats of the whole Mediterranean region, the main groups being *A. sterilis byzantina* and *A. sterilis algeriensis.* In the United States also the *A. sterilis* forms are widely cultivated, the well-known varieties Red Rustproof and Burt being the principal representatives.

The following description covers the cultivated forms of *A. sterilis*:

Culms spreading or semi-erect in early growth, fine and stiff; leaves narrow; panicles equilateral; glumes usually longer than in the other cultivated groups; awn usually present on the outer grain and frequently on the inner grain; basal hairs usually present; basilar articulation of the outer grain evident; rhachilla of the outer grain shorter than in most other cultivated forms, while the rhachilla of either the outer or the inner grain is so solidified with the callus of the succeeding grain that the parts do not separate without tearing away the rhachilla itself; caryopsis more elongate than in most other cultivated groups.

Key to varieties

A. Grains dark-colored, brown or black. PAGE
  B. Grains black; awn usually present on both the outer and the inner grain..... *A. sterilis nigra.* 127
  BB. Grains brown to brownish black; awn seldom present on the inner grain..... Sterilis Selection. 129
AA. Grains light-colored, yellow or brownish yellow.
  B. Plants spreading in early growth; basal hairs long (3–6 mm.)..Red Rustproof. 129
  BB. Plants semi-erect in early growth; basal hairs short (1–2.5 mm.) or wanting.
    C. Basal hairs present; basilar articulation of outer grain evident; grains dull yellow.....Burt. 129
    CC. Basal hairs wanting or seldom present; basilar articulation of outer grain usually solidified; grains dun-colored.....King. 130

Descriptions of varieties

Avena sterilis nigra (Plate VIII, 1, and fig. 22).— Culms spreading in early growth, fine, stiff, glabrous or sparsely haired near the nodes; sheaths dark

green and glaucous at period of full heading, partly covering the internode; leaves colored as sheaths, narrow, margins glabrous or sparsely ciliate; panicles short, sparsely branched and fruited, the branches stiff and ascending; spikelets 2–3-grained; glumes dark green and somewhat glaucous at period of full heading, unusually long (28–34 mm.), usually 9–nerved, sometimes 8-nerved; grains black, elongate, outer grains remarkably long (20–25 mm.), long-pointed; lemma glabrous, usually 7-nerved; awn usually present on both the outer and the inner grain, scarcely twisted; basal hairs always present, numerous, bushy, long (3–6 mm.); basilar articulation of the outer grain very marked; rhachilla of the outer grain short (2–2.5 mm.), strong, glabrous, persistent to the second grain. Plants 7–9 dm. tall; late in maturing.

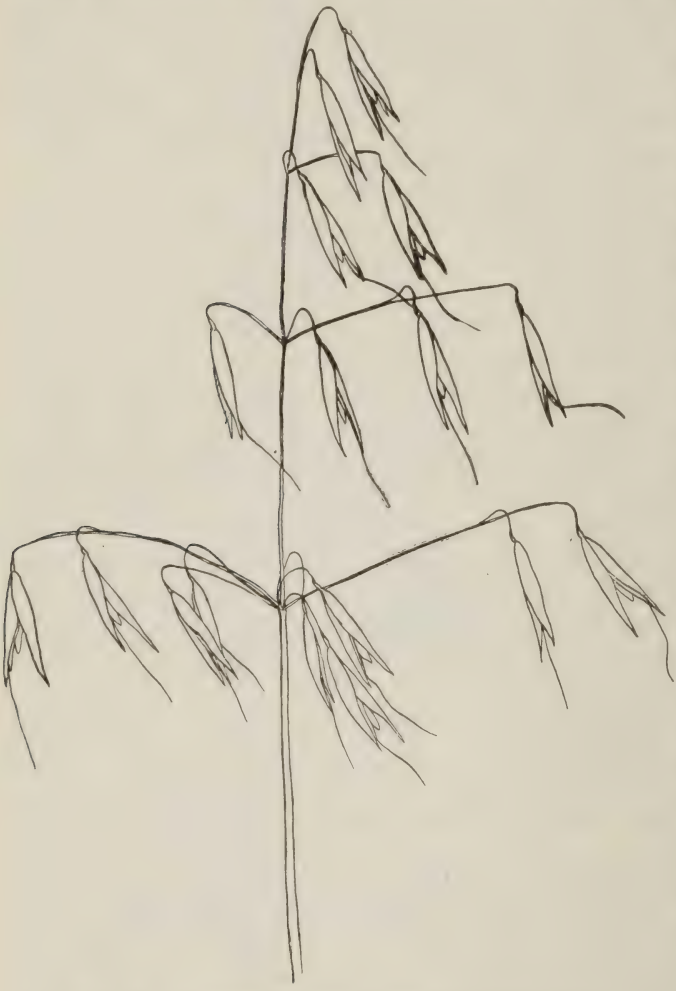

FIG. 22. PANICLE OF AVENA STERILIS (CULTIVATED)
(Panicle representing the varieties *Avena sterilis nigra*, Sterilis Selection, Red Rustproof, Burt, and King)

Sterilis Selection (Plate VIII, 2, and fig. 22).—Culms semi-erect in early growth, otherwise similar to those of *A. s erilis nigra*; sheaths, leaves, panicles, spikelets, and glumes similar to those of *A. sterilis nigra*, except that the glumes are shorter, ranging from 20 to 27 mm., and usually have fewer nerves, 8 nerves being common, although 7- or 9-nerved glumes are occasionally found; grains brown to brownish black, somewhat elongate, outer grains 18-22 mm. long, long-pointed; lemma glabrous, with 7 obscure nerves; awn usually present on the outer grain but seldom on the inner grain, seldom twisted; basal hairs usually present, medium long (2–4 mm.), few to many; basilar articulation of the outer grain nearly solidified, although the lines of separation are usually evident; rhachilla of the outer grain short (2–2.5 mm.), strong, glabrous, persistent to the inner grain. Plants 7–9 dm. tall; late in maturing.

This variety was found mixed with several varieties of black oats of the *A. sativa* group.

Red Rustproof (Plate VIII, 3, and fig. 22).— Culms, sheaths, leaves, panicles, spikelets, and glumes similar to those of *A. sterilis nigra*, except that the glumes are shorter, ranging from 25 to 30 mm., and have fewer nerves, 8 nerves being common, although 7 or 9 nerves may occur; grains brownish yellow, somewhat elongate, outer grains 18–24 mm. long, long-pointed; lemma glabrous, with 7 obscure nerves; awn usually present on the outer grain, frequently on the inner grain, seldom twisted; basal hairs numerous, long (3–6 mm.), bushy; basilar articulation of the outer grain evident; rhachilla of the outer grain short (2–2.5 mm.), strong, glabrous, persistent to the inner grain. Plants 6–9 dm. tall; late in maturing.

Specimens of the variety Red Rustproof were found under the following additional names: Appler, Bancroft, Belgian Vinter, Dun, 100 Bushel, Red Algerian, Red Rustproof (Red Texas), Red Rustproof (Texas Red), Red Rustproof Selection, Regenerated Swedish Select, Swedish Select, Victor, White Maine.

Burt (Plate IX, 1, and fig. 22).— Culms semi-erect in early growth, otherwise similar to those of *A. sterilis nigra*; sheaths, leaves, panicles, spikelets, and glumes similar to those of *A. sterilis nigra*, except that the glumes are shorter, ranging from 25 to 30 mm.; grains dull yellow, elongate outer grains 18 mm. long, long-pointed; lemma glabrous, with 7 obscure nerves; awn usually present on the outer grain and frequently on the inner grain, seldom twisted; basal hairs usually present, numerous, short (1–2.5 mm.),

fine; basilar articulation of the outer grain evident; rhachilla of the outer grain short (2–2.5 mm.), strong, glabrous, persistent to the inner grain. Plants 5–8 dm. tall; medium early in maturing.

Specimens of the Burt variety were found under the following additional names; Early Ripe, Red Rustproof, Unnamed.

King (Plate IX, 2, and fig. 22).— Culms semi-erect in early growth, otherwise similar to those of *A. sterilis nigra*; sheaths, leaves, panicles, spikelets, and glumes similar to those of *A. sterilis nigra*, except that the glumes are shorter, ranging from 20 to 25 mm., and usually have fewer nerves, 8 nerves being common, although 7 or 9 nerves may occur; grains dun-colored, somewhat elongate, outer grains 18–22 mm. long, long-pointed; lemma glabrous, with 7 obscure nerves; awn frequently present on the outer grain but rarely on the inner grain, seldom twisted; basal hairs wanting or seldom occurring; basilar articulation of the outer grain usually solidified, although occasionally the lines of articulation may be seen; rhachilla of outer grain short (2–2.5 mm.), strong, glabrous, persistent to the inner grain. Plants 5–8 dm. tall; medium late in maturing.

AVENA ABYSSINICA

Avena abyssinica, according to Schulz (1913), is distinguished by the structure of its lemma, which extends into four teeth. Körnicke and Werner (1885) give a similar description. Schulz states also that in cultivated forms of *A. abyssinica* the basilar articulation of the grains is solidified; and Trabut (1911) notes a transition of this character between the wild and the cultivated forms, the wild forms having a fragile articulation, while in the cultivated forms the grains are retained.[9] The *A. abyssinica* form is grown in the desert regions of Abyssinia and southern Arabia, chiefly for forage.

AVENA STRIGOSA AND AVENA BREVIS

The closely related groups *Avena strigosa* and *Avena brevis* are distinguished by the structure of the lemma, this having two teeth or awn points at the apex. *A. strigosa* has a lanceolate lemma which extends into distinct awn points, while the lemma of *A. brevis* is short, abrupt, and blunt, and is rather toothed than awn-pointed although in one form the

[9]No specimens of *A. abyssinica* are included in the present classification.

teeth are considerably extended. The basilar articulation in both these species, like that in *A. sativa* and in *A. sativa orientalis,* is solidified. (Plate IV, Plate III, 2, and fig. 23.)

These species have been but little used as cultivated plants, although they still have an isolated cultivation in certain parts of Europe.

AVENA FATUA

Avena fatua is specifically distinguished by the close investment of its kernel, by the distinct articulation of all its grains, and by its hairy, single-pointed lemma. In observing the last-named character, one should not mistake the occasional split-pointed lemma for the distinctly toothed or awn-pointed lemma of *A. brevis* and *A. strigosa.*

Fig. 23. PANICLE OF AVENA BREVIS

A. fatua is generally believed to be the ancestor of *A. sativa* and *A. sativa orientalis,* the two forms which represent the great majority of the cultivated varieties of oats and which are distinguished from the wild form as artificial species by the solidified basilar articulations of their grains (page 132). Because of this relationship, a description of *A. fatua* is here given:

Culms semi-erect in early growth, small to medium large in size, glabrous; sheaths light green and somewhat glaucous at period of full heading;

leaves colored as the sheaths, narrow, margins glabrous; panicles equilateral, wide-spreading, lax, drooping, the branches drooping from the middle outward; spikelets 2–3-grained, although the inner and middle grains often drop at maturity; glumes light green and barely glaucous at period of full heading, 20–25 mm. long, usually 9-nerved; grains black, brown, yellow, or gray, elongate; awn present on all grains, twisted and geniculate; lemma covered with long, stiff hairs; basal hairs present in a bushy ring; rhachilla covered with hairs; basilar articulation of the grains distinct, all grains of the spikelet readily separating from their axes. Plants 8–12 dm. tall; medium late in maturing. (Plate I, 2, and fig. 12.)

A form of *A. fatua* transitional between the wild and the cultivated species is found in *A. fatua glabrata*, received from the Office of Cereal Investigations, United States Department of Agriculture. In this form the basilar articulation of the grains is much reduced, although still distinct. The grains are of three colors — black, yellow, and gray (Plate X); the lemma is usually glabrous and the basal hairs are much reduced; the awn is as strong as in the wild form, although frequently wanting on the inner grains of the black and the gray type; and the rhachilla is haired in the yellow type, but usually glabrous in the black and the gray.

AVENA SATIVA

Avena sativa and *Avena sativa orientalis*, the two groups that include the great majority of cultivated varieties, are distinguished from the foregoing groups by a combination of the following characters: (1) the close investment of the kernel by the hull, as contrasted with the loose kernel of *A. nuda*; (2) the single, more or less abrupt, point of the lemma, as compared with the toothed or awn-pointed lemma of *A. brevis*, *A. strigosa*, and *A. abyssinica*; and (3) the easy separation of the upper grains from their rhachillas, and the solidified articulation of the lower grain, as compared with the persistent upper grains and the slightly articulate lower grain of the cultivated forms of *A. sterilis*. (Plates II, 2, and III, 1.)

The *A. sativa* and *A. sativa orientalis* groups differ specifically only by the unilateral form of panicle of the latter group. There is another character, the non-ligulate and non-auriculate leaf occurring within the *A. sativa orientalis* group, which is not found among varieties of *A. sativa*; but this is not a group characteristic, as it occurs only in a few varieties. Other characters, such as the abnormal node, previously discussed,

extremely wide leaves, and large, coarse stems, are more frequently found in *A. sativa orientalis* than in *A. sativa*. Finally, the early habit of growth of *A. sativa orientalis* is always erect, while that of *A. sativa* may be erect, semi-erect, or spreading. At present *A. sativa orientalis* is grown in the same districts as is *A. sativa*, but less extensively. It is better adapted to the more northerly range of the environment of oats culture.

There is some doubt as to the authenticity of *A. sativa orientalis* as a specific group. It is generally treated as a differentiation of the *A. sativa* group and is believed by Schulz (1913) to have been derived probably from a different form of *A. fatua* from that which gave rise to the commoner form of *A. sativa*. In the present study, *A. sativa orientalis* is regarded as a subgroup of *A. sativa*, and its varieties are placed in a special group merely for convenience in classification.

The description of *A. sativa* is as follows:

Culms spreading, semi-erect, or erect in early growth, large, medium, or small; leaves narrow to medium wide; panicles equilateral; awns occurring only on the outer grain and often wanting; basilar articulation of the grains solidified, but the upper grains are not persistent to their rhachillas, as in *A. sterilis*, and the middle and inner grains are easily removed.

Key to varieties

PAGE

A. Culms spreading, or turf-like, in early growth, numerous in each plant (winter oats).
  B. Grains dark-colored, black, brown, or gray; culms glabrous; plants late in maturing.
    C. Grains black to brownish black; awn present or wanting, seldom geniculate; margins of leaves glabrous ..... C. I. 606. 135
    CC. Grains gray to yellowish gray; awn usually present, usually geniculate; margins of leaves ciliate ..... Winter Turf. 136
  BB. Grains light-colored, white to yellowish white; culms hairy near the nodes; plants early in maturing ..... Culberson. 137
AA. Culms semi-erect or erect in early growth, few to a plant (spring oats).
  B. Grains dark-colored, black to brownish red.
    C. Awns numerous in the panicle.
      D. Grains brownish red to brown; panicles stiff, the branches ascending... Black Norway. 137
      DD. Grains black or brownish black; panicles lax, the branches drooping from the middle outward.
        E. Panicles coarse; glumes 9–10-nerved; plants semi-erect in early growth ..... Victor. 139
        EE. Panicles fine; glumes 8–9-nerved, seldom 10-nerved; plants erect in early growth.
          F. Grains glaucous; rhachilla glabrous ..... Monarch. 139
          FF. Grains not glaucous; rhachilla haired ..... Black Mesdag. 139

PAGE

CC. Awns wanting or few in the panicle.
D. Lemma laterally beset with hairs at about its middle...Black Diamond. 141
DD. Lemma glabrous.
E. Grains glaucous.....Monarch Selection. 141
EE. Grains not glaucous.
F. Panicles narrow, short; plants semi-erect in early growth; grains black.....Joannette. 141
FF. Panicles wide-spreading, long; plants erect in early growth; grains brownish black to brownish red.
G. Grains brownish red; rhachilla usually glabrous...C. I. 620. 142
GG. Grains brownish black; rhachilla usually haired.
H. Panicles extremely long, wide-spreading, and lax, the branches drooping from the middle outward; hairs of the rhachilla few and appressed; grains usually 15–18 mm. long..... Old Island Black. 142
HH. Panicles medium long, stiff, the branches ascending; hairs of rhachilla numerous and erect; grains usually 18–22 mm. long.....North Finnish. 142
BB. Grains light-colored, yellow to white.
C. Lowest whorl of panicle branches usually issuing from a geniculate bend in the rhachis at which the nodal diaphragm is wanting or rudimentary.
D. Panicles narrow, the branches sharply ascending; rhachis scarcely flexuous.....Garton 473. 143
DD. Panicles wide-spreading, the branches stiff but not sharply ascending; rhachis remarkably flexuous.....Garton 691. 143
CC. Lowest whorl of panicle branches issuing from a normal node.
D. Panicles short, sparse; culms fine; plants extremely early in maturing.. Kherson, Early Champion, Sixty-Day. 143
DD. Panicles medium to extremely long, more or less prolific; culms medium to large; plants medium to late in maturing.
E. Grains bright yellow.
F. Basal hairs numerous.
G. Basal hairs short (1–2 mm.); 3-grained spikelets numerous; panicles stiff, the branches ascending...Awnless Probsteier. 146
GG. Basal hairs long (2–5 mm.); 3-grained spikelets seldom occurring; panicles lax, the branches drooping from the middle outward.....Japan Selection. 147
FF. Basal hairs usually wanting, if present few and weak.
G. Awns usually wanting; spikelets usually 2-grained; glumes extremely short (18–22 mm.).....Golden Drop. 147
GG. Awns numerous; 3-grained spikelets numerous; glumes of medium length (20–28 mm.).
H. Awns usually present; spikelets usually 3-grained..... C. I. 603. 147
HH. Awns numerous in the panicle, but frequently wanting in the spikelet; spikelets 2–3-grained.....Green Russian. 148
EE. Grains white to yellowish white.
F. Grains extremely short, outer grains usually less than 15 mm.
G. Leaves, sheaths, and glumes a conspicuous light green at period of full heading; double-grains very numerous....Canadian. 148
GG. Leaves, sheaths, and glumes dark green at period of full heading; double-grains seldom occurring.....Tobolsk. 148

PAGE

FF. Grains medium to extremely long, outer grains usually exceeding 15 mm.
G. Awns usually present and geniculate.
H. Basal hairs numerous, long (2–5 mm.), bushy; grains rather short (15–18 mm.); spikelets 2–3-grained..... Silvermine Selection. 149
HH. Basal hairs wanting, or few, weak, and short (1–2 mm.); grains long (18–22 mm.); spikelets usually 2-grained.... C. I. 602. 149
GG. Awns wanting to numerous in the panicle, seldom geniculate..
H. Basal hairs long (3–6 mm.), numerous.....Early Dakota. 150
HH. Basal hairs short or wanting.
I. Panicles long, lax, spreading, the branches often drooping from the middle outward.
J. Awns wanting or few in the panicle.....Irish Victor. 150
JJ. Awns numerous in the panicle.
K. Grains medium long (16–19 mm.)..Danish Island. 150
KK. Grains extremely long (18–22 mm.)..... Early Gothland. 151
II. Panicles short to medium long, stiff, compact, the branches ascending.
J. Awns wanting or few in the panicle.....Belyak. 151
JJ. Awns few to numerous in the panicle.
K. Rhachilla usually sparsely haired; lemma scarcely concave in the region of the awn; awns few in the panicle.
L. Grains short-pointed.....Silvermine. 151
LL. Grains long-pointed.....Scottish Chief. 152
KK. Rhachilla usually glabrous; lemma concave in the region of the awn; awns numerous in the panicle.
L. Basal hairs usually present, short but bushy and prominent.....June. 152
LL. Basal hairs wanting or weak and inconspicuous.
M. Awns usually strongly twisted; 3-grained spikelets predominating..... Swedish Select. 153
MM. Awns straight or somewhat twisted; 2-grained spikelets predominating..... Lincoln. 154

Descriptions of varieties

C. I.[10] *606* (Plate IX, 3, and fig. 24).— Culms spreading in early growth, but later erect from a somewhat decumbent base, small, stiff, glabrous; sheaths dark green and glaucous at period of full heading; leaves colored as the sheaths, narrow and fine, margins glabrous; panicles narrow, stiff, the branches slightly drooping from the middle outward; spikelets usually 2-grained; glumes dark green and somewhat glaucous at period of full heading, 20–25 mm. long, 7–8-nerved; grains black to brownish black,

[10] Office of Cereal Investigation, United States Department of Agriculture.

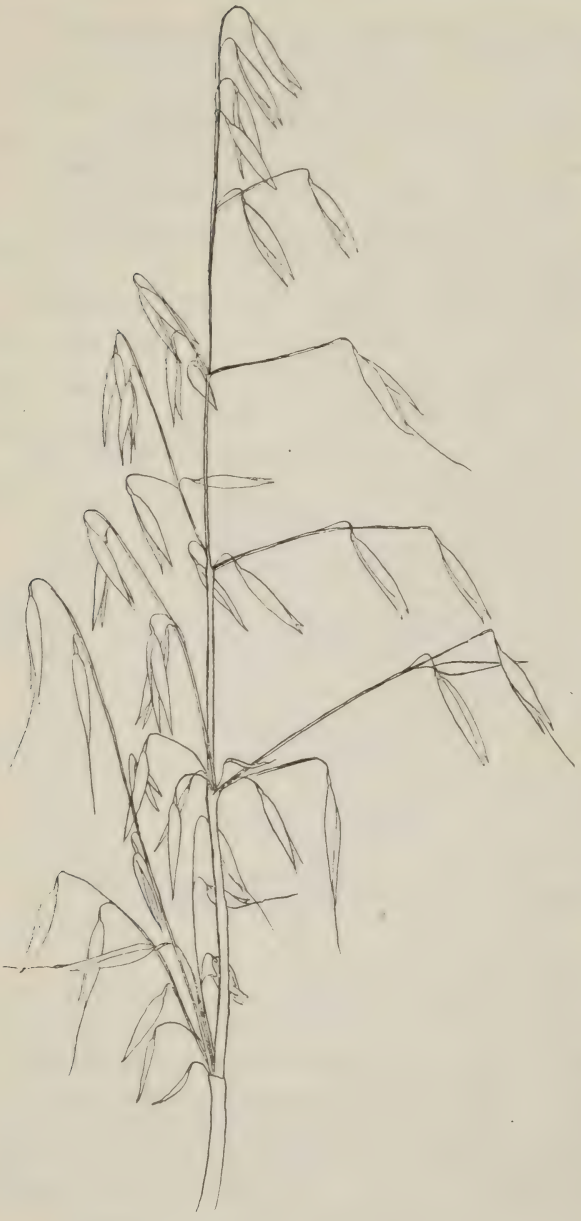

FIG. 24. PANICLE OF AVENA SATIVA
(Panicle representing the varieties C. I. 606, Winter Turf, Culberson, and Joannette)

elongate, outer grains 15–18 mm. long, long-pointed; lemma of the outer grain with 7 obscure nerves, usually glabrous but occasionally with a few lateral hairs; awns few to numerous in the panicle, twisted or not twisted, seldom geniculate; basal hairs usually present, few, short (1–2.5 mm.), and weak; rhachilla of the outer grain 2.5–3.5 mm. long, beset with numerous stiff hairs. Plants 8–10 dm. tall; late in maturing.

Another specimen similar in form to that just described carried the name C. I. 607.

Winter Turf (Plate XI, 1, and fig. 24).—Culms similar to those of C. I. 606; sheaths light green and slightly glaucous at period of full heading; leaves colored as sheaths, narrow and fine, margins ciliate at the lower third; panicles similar to those of C. I. 606, but somewhat broader and longer; spikelets usually 2-grained; glumes light

green and barely glaucous at period of full heading, 20–25 mm. long, usually 9-nerved, in some cases 8-nerved; grains gray to yellowish gray, plump, conspicuously striped, outer grains 15–18 mm. long, short-pointed: lemma of the outer grain glabrous, with 7 conspicuous nerves; awns numerous in the panicle, twisted, and usually geniculate; basal hairs usually present, few or numerous, 1–4 mm. long, weak; rhachilla of the outer grain short (1.5–2.5 mm.), usually carrying a few weak hairs. Plants 8–10 dm. tall; extremely late in maturing.

Specimens of the variety Winter Turf were found under the following additional names: Dewey, Gray Winter, Oregon Gray, Silvermine, Sonoma, Virginia Gray Winter, Winter Turf Selection.

Culberson (Plate XI, 2, and fig. 24).— Culms similar to those of C. I. 606, but hairy near the nodes; sheaths, leaves, panicles, spikelets, and glumes similar to those of Winter Turf, except that the margins of the leaves are usually glabrous or only sparingly ciliate, and the glumes are more commonly 8-nerved than 9-nerved; grains white to yellowish white, elongate, outer grains 15–18 mm. long, long-pointed; lemma of the outer grain glabrous, with 7 obscure nerves; awns usually present, usually twisted, frequently geniculate; basal hairs few and weak, 1–3 mm. long, often wanting; rhachilla of the outer grain 2–3 mm. long, usually glabrous, hairs if present few, short, and weak. Plants 8–10 dm. tall; medium early in maturing.

A specimen of the variety Culberson was found under the name Burt.

Black Norway (Plate XI, 3, and fig. 25.)— Culms erect in early growth, large, stiff, glabrous; sheaths dark green and glaucous at period of full heading; leaves colored as the sheaths, medium wide, margins glabrous or sparsely ciliate; panicles broad, stiff, the branches ascending; spikelets 2-grained, seldom 3-grained; glumes dark green and slightly glaucous at period of full heading, 20–25 mm. long, 9–10-nerved; grains brownish red to brown, plump, outer grains usually 14–17 mm. long, short-pointed; lemma of the outer grain glabrous, with 7 prominent nerves; awns usually present, usually twisted, seldom geniculate; basal hairs usually wanting, if present short (1–2 mm.), few, and weak; rhachilla of the outer grain short (2–2.5 mm.), usually haired. Plants 9–12 dm. tall; late in maturing.

Another specimen of the variety Black Norway carried the name White Schoenen.

FIG. 25. PANICLE OF AVENA SATIVA

(Panicle representing the varieties Black Norway, North Finnish, Awnless Probsteier, Golden Drop, C. I. 603, Green Russian, Silvermine Selection, Belyak, Scottish Chief, June, Swedish Select, and Lincoln)

Victor (Plate XII, 1).— Culms semi-erect in early growth, large, coarse, stiff, glabrous; sheaths dark green and glaucous at period of full heading; leaves colored as the sheaths, medium wide, margins glabrous or sparsely ciliate; panicles long, broad, coarse, wide-spreading, lax, the branches usually drooping from the middle outward; spikelets 2-grained, 3-grained spikelets seldom occurring, double-grains many; glumes dark green and slightly glaucous at period of full heading, 25–30 mm. long, 9–10-nerved; grains black to brownish black, very large and coarse, outer grains usually 18–22 mm. long, rather short-pointed; lemma of the outer grain glabrous, the number of nerves varying from 7 to 10; awns usually present, strong, coarse, twisted, often slightly geniculate; basal hairs wanting on most grains, although often present, short to medium long (2–4 mm.), and stiff; rhachilla of the outer grain 2–3 mm. long, usually weakly haired. Plants 10–14 dm. tall; medium late in maturing.

Specimens of the variety Victor were found under the following additional names: Black Egyptian, English Wonder, Garton 306, Garton 396, Garton 453, Garton 1174.

Monarch (Plate XII, 2, and fig. 26).— Culms erect in early growth, medium large, stiff, glabrous or hairy near the nodes; sheaths dark green and glaucous at period of full heading; leaves colored as the sheaths, narrow to medium wide, margins glabrous; panicles wide-spreading, lax, the branches drooping from the middle outward; spikelets usually 2-grained; glumes dark green and slightly glaucous at period of full heading, 20–27 mm. long, usually 9-nerved, in some cases 8- or 10-nerved; grains brownish black, glaucous, elongate, outer grains usually 15–19 mm. long, long-pointed; lemma of the outer grain glabrous, with 7 obscure nerves; awns usually numerous in the panicle, scarcely twisted; basal hairs usually present, short to long (2–5 mm.), fine, and weak; rhachilla of the outer grain short (1.5–2.5 mm.), usually glabrous. Plants 8–10 dm. tall; medium early in maturing.

Specimens of the variety Monarch were found under the following additional names: Hennesey, Martinsburg, Red Rustproof, Swedish Red, Tartarian, Texas Red.

Black Mesdag (Plate XII, 3, and fig. 26).— Culms erect in early growth, large, stiff, glabrous; sheaths dark green and glaucous at period of full heading; leaves colored as the sheaths, medium wide, margins glabrous; panicles wide-spreading, lax, the branches usually drooping from the middle outward; spikelets usually 2-grained, although 3-grained spikelets occur;

FIG. 26. PANICLE OF AVENA SATIVA

(Panicle representing the varieties Monarch, Black Mesdag, Black Diamond, Monarch Selection, C. I. 620, Old Island Black, Japan Selection, Canadian, Tobolsk, C. I. 602, Early Dakota, Irish Victor, Danish Island, and Early Gothland)

glumes dark green and slightly glaucous at period of full heading, 22–27 mm. long, usually 9-nerved, in some cases 8-nerved; grains black or brownish black, elongate but well filled, outer grains usually 18–22 mm. long, rather short-pointed; lemma of the outer grain glabrous, with 7 obscure nerves; awns usually present, twisted, sometimes geniculate; basal hairs seldom occurring, if present few, short (1–2 mm.), fine, and weak; rhachilla of the outer grain 2–3 mm. long, haired, the hairs long and stiff. Plants 8–10 dm. long, medium early in maturing.

Black Diamond (Plate XIII, 1, and fig. 26).— Culms semi-erect in early growth, medium large, stiff, glabrous; sheaths dark green and glaucous at period of full heading; leaves colored as sheaths, rather narrow, margins glabrous except for the ciliate auricle; panicles long, wide-spreading, lax, the branches drooping from the middle outward; spikelets usually 2-grained; glumes dark green and glaucous at period of full heading, 20–25 mm. long, 9-nerved; grains black to brownish black, plump, outer grains 15–18 mm. long, short-pointed; lemma of the outer grain, and frequently that of the inner grain, laterally beset with hairs, 7 obscure nerves; awns usually wanting; basal hairs few to numerous, fine, short to medium long (1–3 mm.); rhachilla of the outer grain short (1.5–2.5 mm.), usually carrying a few fine hairs. Plants 8–10 dm. tall; late in maturing.

Monarch Selection (Plate XIII, 2, and fig. 26).— Culms erect in early growth, medium large, stiff, and hairy near the nodes; sheaths dark green and glaucous at period of full heading; leaves colored as the sheaths, narrow, margins glabrous; panicles long, narrow, lax, the branches ascending; spikelets 2–3-grained; glumes dark green and slightly glaucous at period of full heading, rather short (18–22 mm.), 9-nerved; grains black, brownish black, or brownish red, glaucous, elongate, outer grains 15–19 mm. long, long-pointed; lemma of the outer grain glabrous, with 7 obscure nerves; awns usually wanting; basal hairs wanting or few, fine, weak, short (1–2 mm.); rhachilla of the outer grain 2–3 mm. long, its hairs short and numerous. Plants 7–9 dm. tall; medium late in maturing.

Joannette (Plate XIII, 3, and fig. 24).— Culms semi-erect in early growth, fine, stiff, glabrous; sheaths light green and somewhat glaucous at period of full heading: leaves colored as the sheaths, narrow, margins glabrous; panicles fine, narrow, stiff, the branches ascending; spikelets usually 2-grained; glumes light green and barely glaucous at period of full heading, 20–25 mm. long, usually 8-nerved, sometimes 7- or 9-nerved; grains black or

brownish black, plump, outer grains 14-19 mm. long, short-pointed; lemma of the outer grain glabrous, with 7 obscure nerves; awns few in the panicle, usually wanting in the spikelet; basal hairs usually present, few, long (2–4 mm.), fine; rhachilla of the outer grain short (1.5–2.5 mm.), usually with long, stiff hairs. Plants 7–9 dm. tall; late in maturing.

Specimens of the variety Joannette were found under the following additional names: Jeannette, Nichol's Black.

C. I. 620 (Plate XIII, 4, and fig. 26).— Culms erect in early growth, medium large, stiff, glabrous; sheaths dark green and glaucous at period of full heading; leaves colored as the sheaths, medium wide, margins glabrous or sparsely ciliate; panicles extremely long, wide-spreading, lax, the branches drooping from the middle outward; spikelets usually 2-grained; glumes dark green and slightly glaucous at period of full heading; grains brownish red, rather elongate, outer grains short (12–17 mm.), either short-pointed or long-pointed; lemma of the outer grain glabrous, with 7 obscure nerves; awns usually wanting; basal hairs short (1–2 mm.), fine, and weak, or wanting; rhachilla of the outer grain 2.5–3.5 mm. long, usually glabrous. Plants 7–9 dm. tall; late in maturing.

Old Island Black (Plate XIII, 5, and fig. 26).— Culms erect in early growth, medium large and stiff, slightly hairy near the nodes; sheaths dark green and glaucous at period of full heading; leaves colored as the sheaths, medium wide, the margins glabrous or sparsely ciliate; panicles extremely long, wide-spreading, lax, the branches drooping from the middle outward; spikelets usually 2-grained; glumes dark green and slightly glaucous at period of full heading, 20–25 mm. long, usually 8-nerved, sometimes 9-nerved; grains black or brownish black, elongate, outer grains 14–18 mm. long, long-pointed; lemma of the outer grains glabrous, with 7 obscure nerves; awns usually wanting; basal hairs wanting or few, short (1–2 mm.), weak; rhachilla of the outer grain 2–3 mm. long, usually with a few appressed hairs. Plants 7–9 dm. tall; medium late in maturing.

Another specimen of the variety Old Island Black was found under the name Black Anthony.

North Finnish (Plate XIII, 6, and fig. 25).— Culms erect in early growth, medium large and stiff, glabrous or hairy near the nodes; sheaths dark green and glaucous at period of full heading; leaves colored as the sheaths, medium wide, margins glabrous; panicles wide-spreading, stiff, the branches ascending; spikelets 2–3-grained; glumes dark green and slightly glaucous

at period of full heading, 22–26 mm. long, usually 9-nerved; grains brownish black, elongate, outer grains usually 18–22 mm. long, long-pointed; lemma of the outer grains glabrous, with 7 rather prominent nerves; awns usually wanting; basal hairs wanting or few, short (1–2 mm.), and weak; rhachilla of the outer grain 2–3 mm. long, with numerous erect hairs. Plants 8–10 dm. tall; medium late in maturing.

Specimens of the variety North Finnish were found under the following additional names: Black American, Black Arctic, Swedish Red.

Garton 473 (Plate XIV, 1, and fig. 27).— Culms erect in early growth, large, coarse, glabrous; sheaths dark green and glaucous at period of full heading; leaves colored as the sheaths, extremely wide, margins ciliate at the lower third; panicles narrow, stiff, the branches sharply ascending and the lowest whorl of branches issuing from a geniculate bend in the rhachis at which the nodal diaphragm is wanting or rudimentary; spikelets 2-grained, double-grains very numerous; glumes dark green and slightly glaucous at period of full heading, 25–30 mm. long, usually 9-nerved but may be 10–11-nerved; grains white or yellowish white, large and coarse, outer grains usually 18–22 mm. long, short-pointed; lemma of the outer grain with 7–11 conspicuous nerves, usually 7-nerved, glabrous; awns numerous in the panicle, coarse, usually twisted, in some cases slightly geniculate; basal hairs wanting, or short (1–2 mm.), few, and weak; rhachilla of the outer grain 2–3 mm. long, glabrous or with a few weak hairs. Plants 8–10 dm. tall; medium late in maturing.

Specimens of the variety Garton 473 were found under the following additional names: Garton 855, Golden Rain, Regenerated Swedish Select.

Garton 691 (Plate XIV, 1, and fig. 27).— Similar to Garton 473, except that the panicle is longer and wide-spreading, with stiff but not sharply ascending branches, and that the rhachis is remarkably flexuous.

Kherson, Early Champion, Sixty-Day.— Characterized chiefly by short, sparse, fine, stiff panicles (fig. 28), fine stems, and early maturity. In the specimens of Kherson and Sixty-Day, yellow and white grains occurred in various proportions, while in the specimens of Early Champion the grains were white. The grains of Kherson and Sixty-Day were separated as yellow and white, and each class was found to reproduce its color accurately. As the original introduction of Kherson oats by the Nebraska Experiment Station in 1896 was a yellow-grain variety, the white grains

FIG. 27. PANICLE OF AVENA SATIVA
(Panicles representing the varieties Garton 473 and Garton 691)

found among the specimens under study are regarded merely as a mixture of Sixty-Day, introduced later. Accordingly the names Kherson and Sixty-Day are here applied respectively to the separated yellow and white forms.

PAGE

A. Grains yellow.
  B. Awns few in the panicle.....Kherson. 145
  BB. Awns numerous in the panicle.....Kherson Selection. 145
AA. Grains white.
  B. Spikelets usually 3-grained.
    C. Grains short, 15–18 mm.; awns few in the panicle.....Sixty-Day. 145
    CC. Grains extremely long, 18–22 mm.; awns numerous in the panicle.....
      Sixty-Day Selection 145
  BB. Spikelets usually 2-grained, 3-grained spikelets seldom occurring.....
    Early Champion. 146

Kherson (Plate XIV, 2, and fig. 28).— Culms erect in early growth, fine, stiff, either smooth or slightly pubescent at the nodes; sheaths dark green, glaucous; leaves colored as the sheaths, fine, narrow, short, margins smooth; panicles short, sparse, fine, stiff, the branches ascending; 3-grained spikelets numerous in the panicle, often predominating over 2-grained spikelets; glumes dark green and slightly glaucous at time of full heading, 9-nerved, in some cases 8-nerved; grains yellow, somewhat elongate, outer grains 16–20 mm. long, long-pointed; lemma of the outer grain glabrous, with 5–7 obscure nerves; awns usually wanting, if present short and weak; basal hairs seldom occurring, if present few and weak; rhachilla of the outer grain 2–3 mm. long, glabrous. Plants 6–9 dm. tall; extremely early in maturing.

Kherson Selection.— Differs from Kherson only in the greater number of awns in the panicle.

Sixty-Day (Plate XIV, 3).— Differs from Kherson only in having white, slightly shorter grains.

Sixty-Day Selection (Plate XIV, 4).— Differs from Sixty-Day in its longer, larger, and horn-white to yellow grain, more frequent awns, occasional 10-nerved glume, and somewhat later maturing period.

Among the mixed specimens of Kherson and Sixty-Day were found the following additional names: Appler, Bucium, C. I. 579, Champion, Culberson, Daubeney, Early Champion, Early Illinois, Hays, Kherson (Nebraska No. 1), Ray's 5610, Seventy-five Day, Sixty-Day (C. I. 165), Sixty-Day (C. I. 639), Sixty-Day (Minnesota 261).

Early Champion (Plate XIV, 5).— Differs from Sixty-Day in its predominating 2-grained spikelet, somewhat plumper grain, and occasional hairs of the rhachilla, which when present are few and weak.

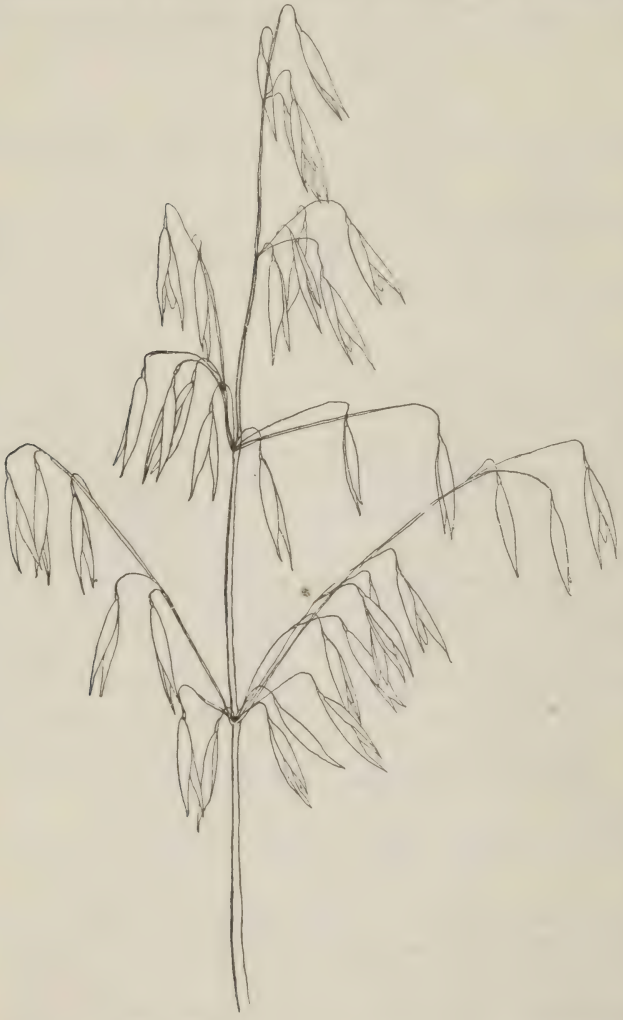

FIG. 28. PANICLE OF AVENA SATIVA
(Kherson)

Specimens of the variety Early Champion were found under the following additional names: Champion, Daubeney, Iowa Silvermine, New Champion, Seventy-five Day.

Awnless Probsteier (Plate XIV, 6, and fig. 25).— Culms erect in early growth, medium large, stiff, usually hairy near the nodes; sheaths dark green and glaucous at period of full heading; leaves colored as the sheaths, medium wide, margins smooth; panicles medium long, wide, stiff, the branches ascending; spikelets 2–3-grained; glumes dark green and somewhat glaucous at period of full heading, 23–27 mm. long, 9–10-nerved; grains bright yellow, somewhat elongate, outer grains 16–20 mm. long, rather long-pointed; lemma of the

outer grain glabrous, with 7 prominent nerves; awns wanting or seldom occurring; basal hairs numerous, short (1–2 mm.), bushy; rhachilla of the outer grain 1.5–2.5 mm. long, glabrous or with a few weak hairs. Plants 8–10 dm. tall; medium early in maturing.

Specimens of the variety Awnless Probsteier were found under the following additional names: American Banner, Appler, Danish.

Japan Selection (Plate XV, 1, and fig. 26).— Culms, sheaths, and leaves similar to those of Awnless Probsteier; panicles rather long, lax, wide-spreading, the branches drooping from the middle outward; spikelets usually 2-grained; glumes colored as those of Awnless Probsteier, 20–25 mm. long, 9–10-nerved; grains bright yellow, elongate, outer grains 15–18 mm. long, long-pointed; lemma of the outer grain glabrous, with 7 obscure nerves; awn usually wanting; basal hairs usually numerous, medium long (2–4 mm.), and weak; rhachilla of the outer grain 2–3 mm. long, usually glabrous. Plants 7–9 dm. tall; medium early in maturing.

The variety Japan Selection was found as a mixture among specimens of white-grained oats bearing the names Japan and Lincoln.

Golden Drop (Plate XV, 2, and fig. 25).—Culms, sheaths, and leaves similar to those of Awnless Probsteier; panicles medium in size, wide, stiff, the branches ascending; spikelets usually 2-grained; glumes colored similarly to those of Awnless Probsteier, remarkably short (18–22 mm.), 9-nerved; grains bright yellow, plump, outer grains short (13–16 mm.), short-pointed; lemma of the outer grain glabrous, with 7 obscure nerves; awns usually wanting; basal hairs usually wanting, if present few, short, and weak. Plants 8–10 dm. tall; medium early in maturing.

Specimens of the variety Golden Drop were found under the following additional names: Early Mountain, Golden Rain, Hunt, Kirsche, Large Yellow, Tartar King, White Queen, Wideawake, Yellow.

C. I. 603 (Plate XV, 3, and fig. 25).—Culms, sheaths, and leaves similar to those of Awnless Probsteier; panicles of medium size, stiff, the branches ascending; spikelets usually 3-grained; glumes dark green and somewhat glaucous at period of full heading, 20–25 mm. long, 8–10-nerved; grains bright yellow, rather elongate, outer grains 15–18 mm. long, rather long-pointed; lemma of the outer grains glabrous, with 7 prominent nerves; awns usually present and not twisted; basal hairs usually wanting, if present short, few, and weak; rhachilla of the outer grain extremely short (1–2 mm.), glabrous. Plants 7–9 dm. tall; medium early in maturing.

Another specimen of the variety C. I. 603 was found under the name Golden.

Green Russian (Plate XVI, 1, and fig. 25).—Culms, sheaths, and leaves similar to those of Awnless Probsteier; panicles similar to those of C. I. 603, but somewhat larger; spikelets 2–3-grained; glumes dark green and somewhat glaucous at period of full heading, 20–28 mm. long, 9–10-nerved; grains bright yellow, somewhat elongate, outer grains 16–20 mm. long, rather long-pointed; lemma of the outer grain glabrous, with 7 prominent nerves; awns numerous in the panicle, but frequently wanting in the spikelet, usually not twisted; basal hairs usually wanting, if present few, short, and weak; rhachilla of the outer grain 2–3 mm. long, glabrous. Plants 7–10 dm. tall; medium early in maturing.

Specimens of the variety Green Russian were found under the following additional names: American Triumph, Anderbeck, Big Four, Bonanza King, C. I. 582, C. I. 608, Columbia, Early Champion, Golden, Golden Beauty, Golden Cluster, Great Dane, Holstein Prolific, Irish Victor, Minnesota 202, Rossman, Siberian, Watson, Welcome.

Canadian (Plate XVI, 2, and fig. 26).—Culms erect in early growth, large, weak, glabrous; sheaths pale green, slightly glaucous; leaves colored as sheaths, but streaked and not uniform in color, wide, 20–25 mm., margins ciliate at lower third; rhachis slightly flexuous; panicles long, lax, drooping at the apex, branches wide-spreading and drooping from the middle outward; 2-grained spikelets (usually double-grains) predominant, 3-grained spikelets seldom occurring; glumes pale green, 9-nerved; grains white to pale yellow, very short and plump, outer grains 13–16 mm. long, short-pointed; lemma of the outer grain glabrous, usually 9-nerved; awns present in about one-half the total number of spikelets, long but seldom twisted, and rarely geniculate; basal hairs wanting or few, short to long (1–5 mm.), weak; rhachilla of the outer grain 2.5–3.5 mm. long, glabrous. Plants 9–11 dm. tall; medium early in maturing.

Specimens of the variety Canadian were found under the following additional names: Abundance, Canadian White, Lincoln, Probsteier, White Tartar.

Tobolsk (Plate XVI, 3, and fig. 26).—Culms erect in early growth, medium large, stiff, glabrous; sheaths dark green and glaucous at period of full heading; leaves colored as the sheaths, medium wide, margins smooth; panicles medium long, wide-spreading, lax, the branches drooping from the middle

outward; spikelets 2-grained; glumes dark green and somewhat glaucous at period of full heading, 20–25 mm. long, 9-nerved; grains white, plump, outer grains extremely short (usually 12–15 mm.), short-pointed; lemma of the outer grain glabrous, with 7 obscure nerves; awns numerous in the panicle, usually twisted, sometimes slightly geniculate; basal hairs wanting; rhachilla of the outer grain 2–3 mm. long, glabrous or with a few weak hairs. Plants 8–10 dm. tall; medium early in maturing.

Another specimen of the variety Tobolsk was found under the name Wisconsin Pedigree No. 3.

Silvermine Selection (Plate XVII, 1, and fig. 25).— Culms erect in early growth, medium large, stiff, hairy near the nodes; sheaths dark green and glaucous at period of full heading; leaves colored as the sheaths, medium wide, margins smooth; panicles of medium size, somewhat lax, the branches often drooping; spikelets 2–3-grained; glumes dark green and glaucous at period of full heading, 20–25 mm. long, usually 9-nerved, sometimes 10-nerved; grains white, plump, outer grains 15–18 mm. long, short-pointed: lemma of the outer grain glabrous, with 7 prominent nerves; awns usually present, twisted and geniculate; basal hairs numerous, long (2–5 mm.), bushy; rhachilla of the outer grain short (1.5–2.5 mm.), usually glabrous. Plants 8–10 dm. tall; medium late in maturing.

The variety Silvermine Selection was found as a mixture among several specimens of Silvermine and other white-grained varieties.

C. I. 602 (Plate XVII, 2, and fig. 26).— Culms erect in early growth, medium large, stiff, glabrous; sheaths light green and glaucous at period of full heading; leaves colored as the sheaths, wide, margins smooth; panicles extremely long, wide-spreading, lax, drooping at the apex, the branches usually ascending; spikelets usually 2-grained; glumes light green and somewhat glaucous at period of full heading, 20–25 mm. long, usually 9-nerved, sometimes 10-nerved; grains white, elongate, outer grains 17–22 mm. long, long-pointed; lemma of the outer grain glabrous, with 7 obscure nerves; awns usually present, twisted and geniculate; basal hairs usually wanting, if present few, short, and weak; rhachilla of the first grain 2–3 mm. long, usually with a few weak hairs. Plants 9–12 dm. tall; late in maturing.

Specimens of the variety C. I. 602 were found under the names Canadian and C. I. 597, and were also found as a mixture among several other varieties of white-grained oats.

Early Dakota (Plate XVII, 3, and fig. 26).— Culms, sheaths, leaves, and glumes similar to those of C. I. 602, except that the culms are usually hairy near the nodes; panicles long and spreading, often drooping at the apex, although the branches are usually ascending; spikelets usually 2-grained; grains yellowish white, rather elongate, outer grains 15–18 mm. long, rather long-pointed; lemma of the outer grain glabrous, with 7 obscure nerves; awns wanting or few in the panicle; basal hairs numerous, long (3–6 mm.), bushy; rhachilla of the outer grain 2–3 mm. long, haired, the hairs often numerous and conspicuous. Plants 8–10 dm. tall; late in maturing.

Specimens of the variety Early Dakota were found under the following additional names: Abbott, Big Four, Early Gotham.

Irish Victor (Plate XVIII, 1, and fig. 26).—Culms, sheaths, leaves, panicles, and glumes similar to those of Early Dakota; spikelets 2–3-grained, 2-grained spikelets predominating; grains white or yellowish white, somewhat elongate, outer grains 16–19 mm. long, usually long-pointed; lemma of the outer grain glabrous, with 7 obscure nerves; awns wanting or few in the panicle; basal hairs usually wanting, if present few, weak, and short; rhachilla of the first grain 2–3 mm. long, usually glabrous. Plants 8–11 dm. tall; late in maturing.

Specimens of the variety Irish Victor were found under the following additional names: Alaska, American Banner, Czar of Russia, Early Illinois, Fourth of July, Golden Fleece, Great Dakota, Green Mountain, Japan, Lincoln, Mammoth White Side, Minnesota 202, Siberian Sixty-Day, Stavropol, Sunshine, Swedish Select, Twentieth Century, Welcome, White, White Bedford, White Bonanza, White Main, White Queen, White Sensation, Wilson's Prolific.

Danish Island (Plate XVIII, 2, and fig. 26).— Culms, sheaths, leaves, panicles, spikelets, and glumes similar to those of Early Dakota; grains white or yellowish white, elongate, outer grains 16–19 mm. long, long-pointed; lemma of the outer grain glabrous, with 7 obscure nerves; awns numerous in the panicle; basal hairs usually wanting, if present few, weak, and short; rhachilla of the outer grain 2–3.5 mm. long, glabrous or with a few weak hairs. Plants 9–12 dm. tall; late in maturing.

Specimens of the variety Danish Island were found under the following additional names: Champion, Garton 689, Green Mountain, Heavy Weight, Red Rustproof, Unnamed White.

Early Gothland (Plate XVIII, 3, and fig. 26).— Culms, sheaths, leaves, panicles, and glumes similar to those of Early Dakota, except that the glumes are somewhat longer; spikelets 2–3-grained; grains white to yellowish white, elongate, outer grains 18–22 mm. long, long-pointed; lemma of the outer grain glabrous, with 7 obscure nerves; awns numerous in the panicle, usually not twisted; basal hairs extremely short (1–2 mm.), numerous; rhachilla of the outer grain 2–3 mm. long, usually haired. Plants 9–11 dm. tall; late in maturing.

Specimens of the variety Early Gothland were found under the following additional names: Banner, Danish, Schoenen.

Belyak (Plate XVIII, 4, and fig. 25).— Culms erect in early growth, medium large, stiff, hairy near the nodes; sheaths dark green and glaucous at period of full heading; leaves colored as the sheaths, medium wide, margins glabrous; panicles medium long, rather broad, somewhat compact, stiff, erect, the branches ascending; spikelets 2–3-grained; glumes dark green and somewhat glaucous at period of full heading, 20–25 mm. long, usually 9-nerved, sometimes 10-nerved; grains white to yellowish white, plump, outer grains 16–19 mm. long, short-pointed, the dorsal side concave in the region of the awn; lemma of the outer grain glabrous, with 7 obscure nerves; awns wanting or few in the panicle, seldom twisted; basal hairs wanting or extremely short; rhachilla of the outer grain short (1.5–2.5 mm.), usually glabrous. Plants 9–11 dm. tall; medium late in maturing.

Another specimen of the variety Belyak was found under the name White Belyak.

Silvermine (Plate XIX, 1, and fig. 29).— Culms, sheaths, leaves, panicles, and glumes similar to those of Belyak, except that the panicles are more elongate and their branches ascend more sharply; spikelets 2–3-grained, 2-grained spikelets largely predominating; grains white to yellowish white, plump, outer grains 16–19 mm. long, short-pointed, the dorsal side scarcely concave in the region of the awn; lemma of the outer grain glabrous, with 7 obscure nerves; awns wanting or few in the panicle, usually not twisted; basal hairs usually wanting; rhachilla of the outer grain 2–3 mm. long, usually with a few weak, short hairs. Plants 9–11 dm. tall; medium late in maturing.

Specimens of the variety Silvermine were found under the following additional names: American Banner, Big Four, Big Four (Salzer's), Boehmerwald Mountain, Bussey, Canadian, Curel 6, Danish Island,

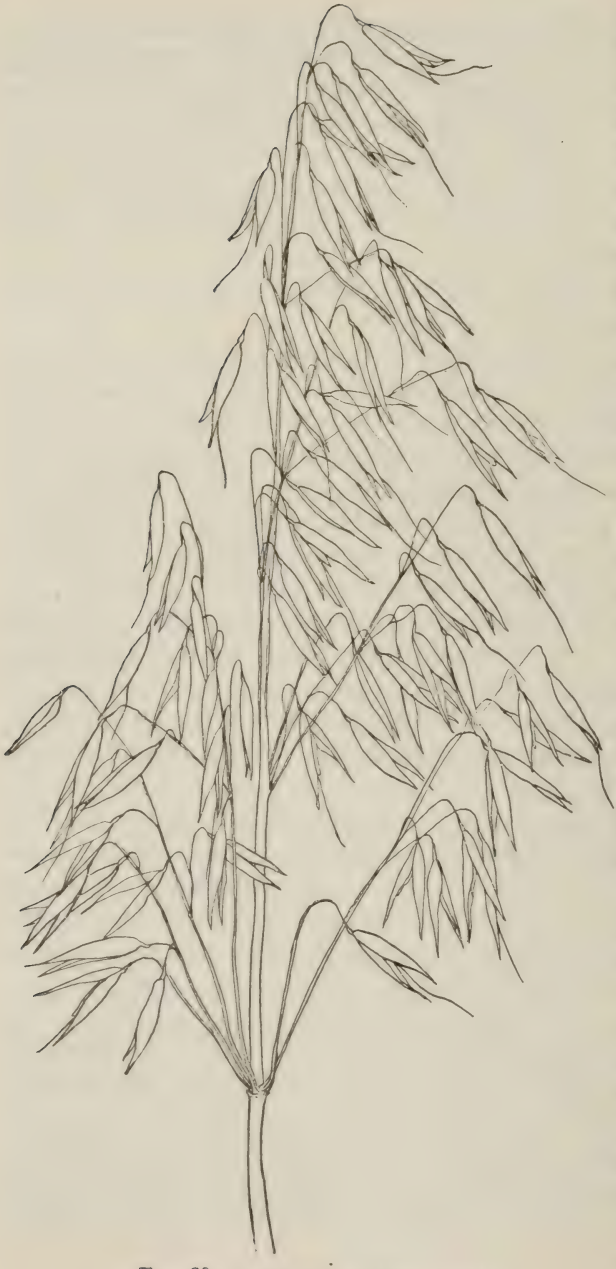

FIG. 29. PANICLE OF AVENA SATIVA
(Silvermine)

Emperor William, Funk, Funk's Great Dane, Garton 364, Great American, Great Dakota, Illinois German, Lincoln, Minnesota 368, Morganfellow, National, New Zealand, Swedish Select, Welcome, Wideawake, Zhelannii.

Scottish Chief (Plate XIX, 2, and fig. 25).— Culms, sheaths, leaves, panicles, spikelets, and glumes similar to those of Belyak; grains somewhat similar to those of Silvermine, but longer (17–20 mm.) and long-pointed; hairs of the rhachilla more prominent than in Silvermine. Plants 8–11 dm. tall; medium late in maturing.

Specimens of the variety Scottish Chief were found under the following additional names: Goldmine, New Johnson, Swedish Select, White Tartar.

June (Plate XIX, 3, and fig. 25):— Culms, sheaths, leaves, panicles, and glumes similar to those of Belyak; spikelets 2–3-

grained, 3-grained spikelets predominating; grains somewhat similar to those of Belyak, but in some cases longer (16–20 mm.); awns numerous in the panicle, slightly twisted; basal hairs numerous, short (1–2 mm.), bushy; rhachilla of the outer grain short (1.5–2.5 mm.), glabrous. Plants 8–11 dm. tall; medium late in maturing.

Swedish Select (Plate XIX, 4, and fig. 25).— Culms, sheaths, leaves, panicles, and glumes similar to those of Belyak; spikelets 2–3-grained, 3-grained spikelets predominating; grains similar in form, size, and color to those of Belyak; awns very numerous in the panicle, strongly twisted, black at the base; basal hairs wanting, or extremely short, few, and weak; rhachilla of the outer grain 2–3 mm. long, usually glabrous. Plants 8–11 dm. tall; medium late in maturing.

Specimens of the variety Swedish Select were found under the following additional names: Abundance, Abyssinian, Achottatt, American Banner (Wisconsin 36), American Triumph, Archangel, Avena (Zook), Bancroft, Banner, Barley, Beseler, Beseler I (C. I. 592), Beseler II (C. I. 589), Beseler II (C. I. 600), Big Four, Big Four (Minnesota 353), Black Bell (C. I. 496), Bumper Crop, Canada Cluster, Canadian (Minnesota 429), C. I. 570, C. I. 576, C. I. 594, C. I. 604, C. I. 605, C. I. 618, Clydesdale, Clydesdale (Michigan 104), Colorado, Conqueror, Czar of Russia, Danish, Danish (C. I. 441), Danish Giant (C. I. 672), Danish Island, Danish White, Delmaine, Early Champion (Minnesota 267), Early Gothland (Minnesota 26), Early Gothland (Minnesota 295), Early Gothland (Minnesota 431), Emperor William, English, Fichtel Mountain, Fulghum, Garton 436, Garton 436 (C. I. 565), Garton 450, Garton 466, Garton 611, Garton's Swedish Select (Minnesota 430), Golden Cluster, Golden Fleece, Golden Rustproof, Goldmine, Great American, Great Dakota, Great Northern, Green Mountain, Heavy Weight, Henderson's Large White, Hungarian White, Illinois German, Imported Clydesdale, Improved Ligowo (Minnesota 6), Improved Ligowo (Minnesota 281), Irish Victor, Japan, Kirsche's Original (Minnesota 437), Leutewitz (C. I. 593), Ligowo (C. I. 525), Ligowo (C. I. 500), Ligowo (C. I. 599), Ligowo (C. I. 640), Ligowo (Minnesota 6), Ligowo II (C. I. 492), Lincoln, Lincoln (C. I. 575), Lincoln (Minnesota 340), Minnesota 270, Minnesota 436, Morganfellow, Mortgage Lifter, National (Salzer's), New Alberta, New Danish, Newmarket, Newmarket (Minnesota 428), Nichol's White Comet, Oderbrucker, Oregon Gray Winter (C. I. 436), Pickett (Michigan 102), President, Progress, Prosperity, Regenerated Abundance (C. I. 642), Regenerated Swedish Select, Regenerated Swedish Select (Minnesota 383),

Rejuvenated White Bonanza, Rejuvenated White Bonanza (Minnesota 403), Roosevelt, Roosevelt (Minnesota 391), Scotch, Scottish Chief, Senator, Sensation, Siberian, Siberian White, Silvermine, Sparrowbill, Stube (Michigan 100), Swedish Prize Taker, Swedish Select (C. I. 134), Swedish Select (C. I. 674), Swedish Select (Wisconsin 4), Tartar King, Twentieth Century, University 6, Unnamed White, Victory, Welcome (Burpee's), Wernicke's Golden, White, White Beauty, White Bonanza, White Danish, White Maine, White Probsteier, White Queen, White Russian, White Schoenen, White Tartar, White Waverly, Wideawake, Wisconsin Pedigree 1, Wisconsin Pedigree 2, Wisconsin Pedigree 4, Wisconsin Pedigree 5.

Lincoln (Plate XX, 1, and fig. 25).— Similar to Swedish Select, with the following exceptions: 2-grained spikelets usually predominating, rather than 3-grained spikelets; grains somewhat elongate; awns straight or somewhat twisted.

Specimens of the variety Lincoln were found under the following additional names: Alaska, American Banner, American Beauty, Banner, Barley, Bavarian, Bland'd White, C. I. 571, C. I. 601, C. I. 617, Clydesdale, Colorado 37 (C. I. 619), Garton 572, Garton 572 (C.I. 564), Garton 572 (Minnesota 407), Great Dane (C. I. 613), Green Mountain, Hvitling, Improved American, Johnson, Junghaus, Kirsche (C. I. 578), Lactone, Ligowo, Lincoln (C. I. 577), Lincoln (C. I. 715), Michigan Wonder, Minnesota 103, Minnesota 343, Myrick, Myrick Banner (Minnesota 348), National, National (Salzer's), New Sensation, Peerless, "Seedling" (Michigan 101), Sensation, Shadeland Climax, Silvermine, Sparrowbill, Swedish Select, Tartarian (C. I. 713), Tartar King, Victory (C. I. 560), Western Star, White, Wideawake, Wisconsin Wonder.

AVENA SATIVA ORIENTALIS

Culms tall, erect in all stages of growth, generally large, thick, coarse, few in a plant, sheaths usually longer than in *A. sativa* and *A. sterilis*; leaves in most varieties wide and coarse; ligules and auricles wanting in some varieties; panicles unilateral, the branches arising from various sides of the rhachis but converging mostly to one side and being usually sharply ascending or appressed; rhachis in some varieties marked by its extremely flexuous form and by a geniculate bend at which the nodal diaphragm is wanting or rudimentary, although at the bend issue the lowest

whorl of branches; awns when present on the outer grain only, and often wanting; basilar articulation of the grains solidified, as in *A. sativa*. (Plate III, 1.)

Key to varieties

A. Grains dark-colored, black, brown, or gray. PAGE
B. Ligules and auricles wanting.
C. Awns numerous in the panicle; rhachilla of first grain 2–3.5 mm. long, sparsely haired; grains elongate ..... Garton 748. 155
CC. Awns wanting or seldom occurring; rhachilla of first grain 1–2 mm. long, glabrous; grains plump ..... Garton 784. 156
BB. Ligules and auricles present.
C. Grains gray; rhachilla of first grain 1.5–2 mm. long, glabrous; culms usually sparsely haired near the nodes ..... Garton Gray. 156
CC. Grains black to brown; rhachilla of first grain 2.5–3.5 mm. long, sparsely haired; culms glabrous ..... Black Tartarian. 157
AA. Grains light-colored, white or yellow.
B. Ligules and auricles wanting ..... Golden Giant. 157
BB. Ligules and auricles present.
C. Outer grains remarkably short, rarely exceeding 15 mm. in length; spikelets confused in attitude (pointing in all directions) ..... Sparrowbill. 158
CC. Outer grains ranging between 16 and 20 mm. in length, rarely less than 15 mm.; spikelets drooping or pectinate in attitude.
D. Nerves in the glume 11–13; branches of the panicle not appressed, usually drooping from the middle outward ..... Garton 585. 158
DD. Nerves in the glume 8–10; branches of the panicle appressed.
E. Panicles thickly branched and fruited, compact and stiff, the lowest whorl of branches issuing from a bend in the rhachis at which the nodal diaphragm is wanting or rudimentary; margins of leaves ciliate; double-grains very numerous.
F. Basal hairs wanting; nerves of the lemma 8–10; spikelet usually double-grained ..... Storm King. 159
FF. Basal hairs frequently present; nerves of the lemma 7–8; spikelet in about equal numbers double-grained or normal . Tartar King. 160
EE. Panicles sparsely branched and fruited, elongate, slender, lax, drooping, the lowest whorl of branches issuing at a normal node; margins of leaves glabrous; double-grains few.
F. Awns rare; 3-grained spikelets rare ..... White Tartar. 161
FF. Awns numerous in the panicle, usually present in each spikelet; 3-grained spikelets frequent ..... Green Mountain. 162

Descriptions of varieties

Garton 748 (Plate XX, 2, and fig. 30).— Culms erect from early growth, medium large, coarse, glabrous; sheaths dark green and somewhat glaucous at period of full heading, fully covering the internodes; leaves colored as the sheaths, medium wide, margins glabrous; ligules and auricles wanting; rhachis barely flexuous; panicles unilateral, short, stiff, sparsely branched and fruited, the branches appressed, the lowest whorl of branches always issuing from a normal node; spikelets pendant or pectinate in attitude,

2–3-grained; glumes dark green, somewhat glaucous at period of full heading, rather short (20–25 mm.), 8–10-nerved, usually 9-nerved; grains black or smoky brown, with colorless points, rather elongate but well filled, outer grains 15–18 mm. long; lemma of the outer grain glabrous, with 7 prominent nerves; awns numerous in the panicle, black and twisted at the base, often slightly geniculate; basal hairs wanting; rhachilla of the outer grain 2–3.5 mm. long, sparsely haired. Plants 7–10 dm. tall; medium late in maturing.

FIG. 30. PANICLE OF AVENA SATIVA ORIENTALIS

(Panicle representing the varieties Garton 748 and Garton 784)

Garton 784 (Plate XX, 3, and fig. 30).—Similar to Garton 748, with the following exceptions: grains rather plump and somewhat glaucous; awns wanting or seldom occurring; rhachilla of the outer grain remarkably short (1–2 mm.), glabrous.

Specimens of the variety Garton 784 were found also under the names Black Tartarian and Garton 74.

Garton Gray (Plate XX, 4, and fig. 13).—Culms erect in early growth, medium large, usually sparsely haired near the nodes; sheaths dark green and somewhat glaucous at period of full heading, scarcely covering the internodes; leaves colored as the sheaths, medium wide, margins glabrous; ligules and auricles well developed; rhachis barely flexuous; panicles unilateral (resembling the type shown in figure 30, although somewhat longer and more prolific), the branches issuing from a normal node; spikelets pendant or pectinate in attitude, 2–3-grained; glumes dark green, somewhat glaucous, medium long (25–30 mm.), 9-nerved; grains gray or mottled gray and dull yellow, elongate, outer grains 16–20 mm. long, rather long-pointed; lemma of the outer grain glabrous, with 7 obscure nerves; awns usually present, black and twisted at the base; basal hairs usually wanting, when present short, weak, and

few; rhachilla of the outer grain 2–3 mm. long, glabrous or occasionally with a few fine, short hairs. Plants 9–13 dm. tall; medium late in maturing.

Black Tartarian (Plate XXI, 1,and fig. 13).—Culms erect in early growth, large, coarse, glabrous; sheaths dark green and somewhat glaucous at period of full heading, scarcely covering the internodes; leaves colored as the sheaths, extremely wide, margins ciliate; ligules and auricles well developed; rhachis often very flexuous; panicles thickly branched and fruited, compact and stiff, the branches appressed, the lowest whorl of branches usually issuing from a geniculate bend in the rhachis at which the nodal diaphragm is wanting or rudimentary; spikelets pendant or pectinate in attitude, 2–3-grained; glumes dark green, somewhat glaucous at period of full heading, medium in length (23–27 mm.), 8–9-nerved, usually 9-nerved; grains black or brown, somewhat elongate, outer grains 16–20 mm. long, long-pointed; lemma of the outer grain glabrous, with 7–8 prominent nerves; awns usually present, dark-colored and twisted at the base, sometimes slightly geniculate; basal hairs usually wanting, although often present, short and weak; rhachilla of the outer grain 2.5–3.5 mm. long, usually carrying a few short, stiff hairs. Plants 8–10 dm. tall; late in maturing.

Specimens of the variety Black Tartarian were found under the following additional names: Alberta, Black Beauty, Black Egypt, Black Egyptian (Salzer's), Black Prolific (Salzer's), Black Tartar, Danish White, Garton's Black, Probsteier, Sensation.

Golden Giant (Plate XXI, 2, and fig. 13).—Culms erect in early growth, medium large, coarse, usually glabrous but in some cases slightly hairy near the nodes; sheaths dark green and somewhat glaucous at period of full heading, fully covering the internodes; leaves colored as the sheaths, medium wide, margins glabrous; ligules and auricles wanting; rhachis usually straight but may occasionally be slightly flexuous; panicles unilateral, sparsely branched and fruited, slightly drooping at the apex, the branches appressed, the lowest whorl of branches always issuing from a normal node; spikelets pendant or pectinate in attitude, 2–3-grained; glumes dark green and somewhat glaucous at period of full heading, rather short (20–25 mm.), 9–10-nerved, usually 9-nerved; grains bright yellow, elongate, outer grains 18–22 mm. long, long-pointed; lemma of the outer grain glabrous, with 7 obscure nerves; awns usually present, dark-colored and slightly twisted at the base; basal hairs usually wanting,

if present short, weak, and few; rhachilla of the outer grain 1.5–3 mm. long, usually glabrous but occasionally with a few weak, short hairs. Plants 8–12 dm. tall; late in maturing.

Specimens of the variety Golden Giant were found under the following additional names: Golden Giant Side, Jaune Géant à Grappes, Seizure.

Sparrowbill (Plate XXI, 3, and fig. 14).— Culms erect in early growth, large, coarse, glabrous; sheaths dark green and somewhat glaucous at period of full heading, scarcely covering the internodes; leaves colored as sheaths, medium to extremely wide, margins glabrous; ligules and auricles well developed; rhachis often extremely flexuous; panicles thickly branched and fruited, compact, stiff but sometimes slightly drooping at the apex, the branches appressed, the first whorl of branches usually issuing at a normal node but often at a geniculate bend in the rhachis where the nodal diaphragm is wanting or rudimentary; spikelets confused in attitude, 2-grained, rarely 3-grained, double-grains very frequent; glumes light green and barely glaucous at period of full heading, short (20–25 mm.), 8–9-nerved; grains white shading into pale yellow, outer grains remarkably short (12–15 mm.), plump, full, short-pointed; lemma of the outer grain glabrous, with 7 obscure nerves; awns wanting or rare; basal hairs generally present, weak, few, irregular in length (1–5 mm.); rhachilla of the outer grain short (2 mm.), glabrous. Plants 8–10 dm. tall; late in maturing.

Specimens of the variety Sparrowbill were found under the following additional names: Daubeney, Dun, Early Blossom, Standard Challenge, Swedish Select, White Egyptian.

Garton 585 (Plate XXI, 4, and fig. 31).—Culms erect in early growth, medium large, coarse, hairy near the nodes; sheaths dark green and glaucous at period of full heading, scarcely covering the internodes; leaves colored as the sheaths, medium wide, margins glabrous; ligules and auricles well developed; rhachis barely flexuous; panicles somewhat unilateral,[11] although the branches are not appressed but rather drooping from the middle outward, the lowest whorl of branches always issuing from a normal node; spikelets pendant in attitude, 2–3-grained, double-grains numerous; glumes dark green and slightly glaucous at period of full heading, remarkably long (27–32 mm.) and wide, 11–13-nerved; grains dull yellow or white mottled

[11] The classification of Garton 585 is uncertain. Its panicle is intermediate in form between *A. sativa* and *A. sativa orientalis*. It is placed in the latter group merely for convenience in identification.

with dull yellow, very large and coarse, outer grains 18–22 mm. long, short-pointed; lemma of the outer grain glabrous, with 7–9 prominent nerves; awns few in the panicle, coarse but usually not twisted; basal hairs usually wanting, if present few and weak; rhachilla of outer grain remarkably short (1.5–2 mm.) in proportion to the size of the grain, glabrous or occasionally with a few weak, short hairs. Plants 10–12 dm. tall; medium late in maturing.

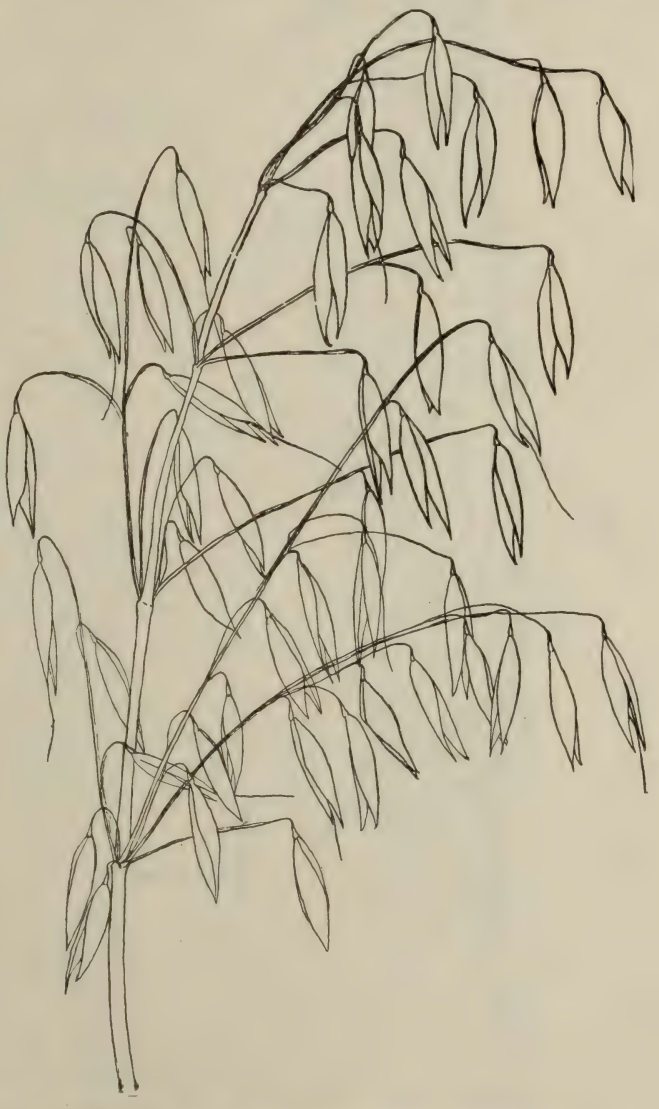

Fig. 31. Panicle of Avena sativa orientalis (Garton 585)

Storm King (Plate XXII, 1, and fig. 32).—Culms erect in early growth, large, coarse, glabrous; sheaths dark green and glaucous at period of full heading, scarcely covering the internodes; leaves colored as sheaths, medium to extremely wide, margins ciliate at lower third; ligules and auricles well

FIG. 32. PANICLE OF AVENA SATIVA ORIENTALIS (Panicle representing the varieties Storm King and Tartar King)

developed; rhachis very flexuous; panicles thickly branched and fruited, compact, stiff, the branches appressed, the first whorl of branches arising from a geniculate bend in the rhachis at which the nodal diaphragm is wanting or rudimentary; spikelets pendant or pectinate in attitude, 2-grained, double-grains predominating; glumes dark green and barely glaucous at period of full heading, rather long (25–30 mm.), 9–10-nerved; grains white, often splotched with dull yellow, coarse; outer grains of medium length (16–20 mm.), very broad, full, rounded, acuminate-pointed; lemma of the outer grain glabrous, usually with 9 prominent nerves; awns few in the panicle, usually not twisted; basal hairs usually wanting; rhachilla of the outer grain 2.5–3 mm. long, glabrous, sunken, often inclosed by the edges of the lemma. Plants 8–11 dm. tall; medium late in maturing.

Specimens of the variety Storm King were found under the following additional names: Avena (Wilcox), C. I. 583, Garton 364, Garton White, Senator, Side, Silver White, Tartar King, Waverly, White Plume.

Tartar King (Plate XXII; 2, and fig. 32).—Similar to Storm King, with the following exceptions: spikelets in about equal numbers double-grained or normal; grains more

elongate; lemma of the outer grain 7–8-nerved; basal hairs frequently present, few, short, and weak.

Specimens of the variety Tartar King were found under the following additional names: American Banner, Black Great Mogul, Canadian Cluster, Clydesdale, Garton 610, Hansen's, Henderson's Large White, Long's White Tartar, New Zealand, Swedish Select, White, White Plume, White Tartar.

White Tartar (Plate XXII, 3, and fig. 33).—Culms erect in early growth, medium large, glabrous; sheaths medium green and somewhat glaucous at period of full heading, scarcely covering the internodes; leaves colored as sheaths, narrow to medium wide, margins smooth; ligules and auricles well developed; rhachis barely flexuous, often tendril-like at the end; panicles medium to extremely long, sparsely branched and fruited, slender, frail, lax, drooping, the branches appressed, the lowest whorl of branches arising at a normal node; spikelets pendant or pectinate in attitude, 2-grained, rarely 3-grained; glumes dark green and barely

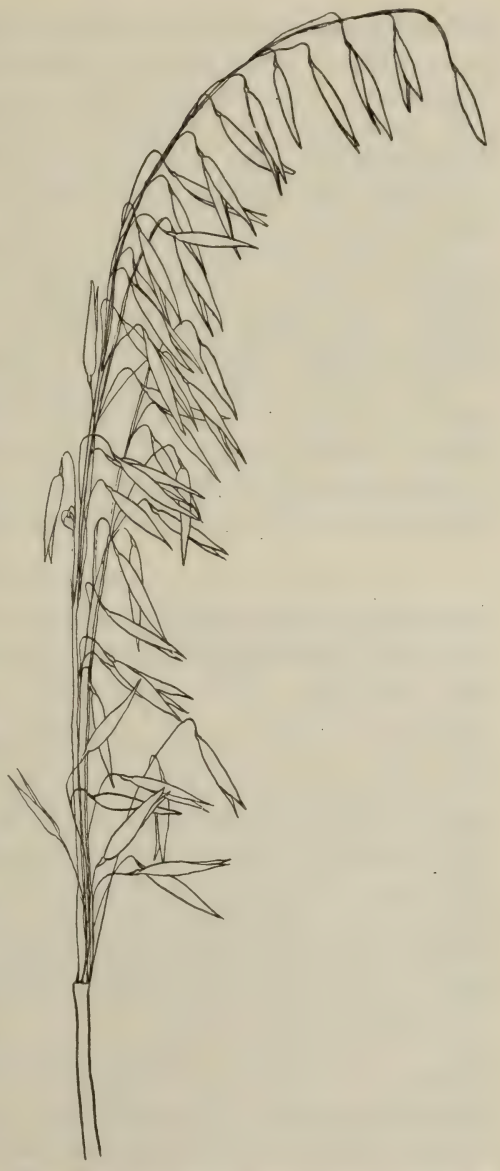

FIG. 33. PANICLE OF AVENA SATIVA ORIENTALIS
(Panicle representing the varieties White Tartar and Green Mountain)

glaucous at period of full heading, short to long (20–30 mm.), 9–10-nerved; grains white to yellowish white, elongate, outer grains 16–19 mm. long, long-pointed; lemma of the outer grain glabrous, with 7 obscure nerves; awns rare; basal hairs usually absent, if present few, short, and weak; rhachilla of the outer grain short to medium long (2–3 mm.), glabrous or in some cases carrying a few short, fine hairs. Plants 10–15 dm. tall; late in maturing.

Specimens of the variety White Tartar were found under the following additional names: American Banner, Danish, Dun, Great Northern, Lincoln, Long's White Tartar, Minnesota 271, Pringles Progress, Read's Green Mountain, Tartarian, White Russian.

Green Mountain (Plate XXII, 4, and fig. 33).—Similar to White Tartar, with the following exceptions: awns numerous in the panicle, usually present in each spikelet; 3-grained spikelets numerous.

Specimens of the variety Green Mountain were found under the following additional names: Read's Green Mountain, White Russian, White Tartar.

CONCLUSION

In the foregoing classification fifty-five varieties have been distinguished within the three common specific groups *A. sterilis*, *A. sativa*, and *A. sativa orientalis*. Within each group the varieties are systematically arranged with respect to such morphological differences as appear to best fulfill the twofold requirement of constancy in inheritance and ease of observation. It cannot be said that the arrangement is according to the strictest order of relationship, for, as previously explained, the modifications in the structure of cultivated plants do not permit a strictly logical taxonomy. Thus a group of varieties having dark-colored grains may include forms that are actually more closely related to certain varieties within a group of light-colored grains than to other members of the dark-colored group. But in a classification which, like the present one, deals with a large number of closely related and interrelated forms, the actual degree of relationship must, in the arrangement of varieties, be subordinate to expediency in identification — which purpose the classification of varieties of cultivated plants chiefly serves.

While the classification presents its arrangement of varieties according to the modifications in their characters as exhibited in the present environment, the arrangement is based mainly on a fundamental morphology

which should reasonably be expected to exhibit similar modifications under other environments. The key for the identification of varieties should therefore, under a wide range of environment, be effective to the point of fixing, at least within narrow limits, the identity of unknown forms.

The choice of variety names herein made is not an attempt to standardize the nomenclature, but rather to point out the names under which the described varieties are probably most frequently grown. As previously explained, the name for a given variety was chosen when it occurred more frequently than any other name among specimens of the variety collected from many different sources. The nomenclature of varieties cannot properly be fixed by a single person acting independently of others who may prefer their own choice of names; but it is important to show that in the lack of a standard nomenclature the name applied to a variety very often has no significance, for numerous different names may be applied to the same form, and the same name may be applied to different forms.

Finally, the classification does not take into account *differences in the ability of varieties to yield.* It is quite possible that many of the synonyms of a given variety may represent forms which differ greatly in this respect and yet exhibit no fundamental variations in structure by which they may be distinguished.

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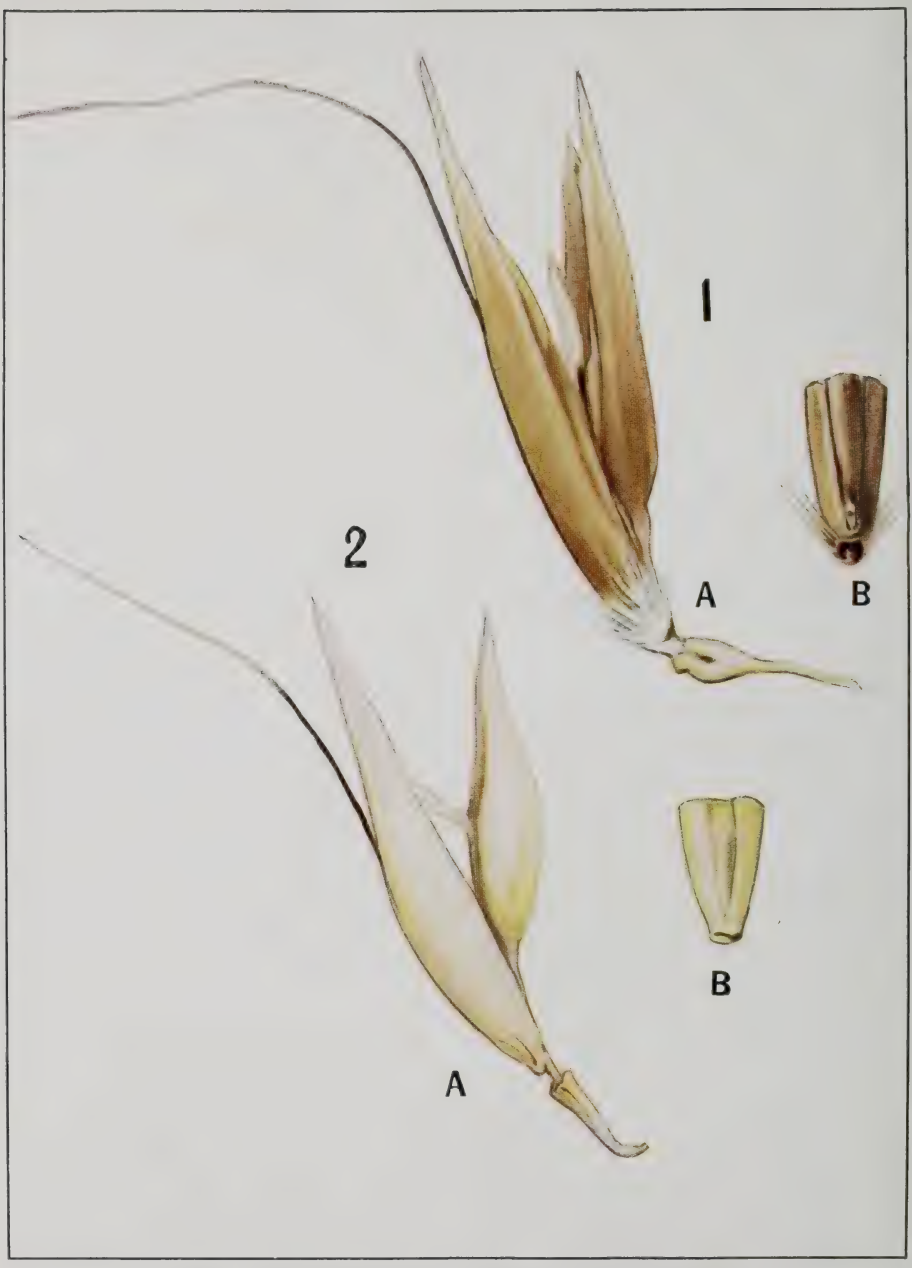
TYPES OF SPIKELETS AND BASES OF OUTER GRAINS

1, *Avena sterilis* (wild form). A. the complete spikelet, with its strong awns and hairy lemmas; B, base of the outer grain, showing its distinct articulating surface and the remnant of the rhachilla, which was torn away with the persistent inner grain

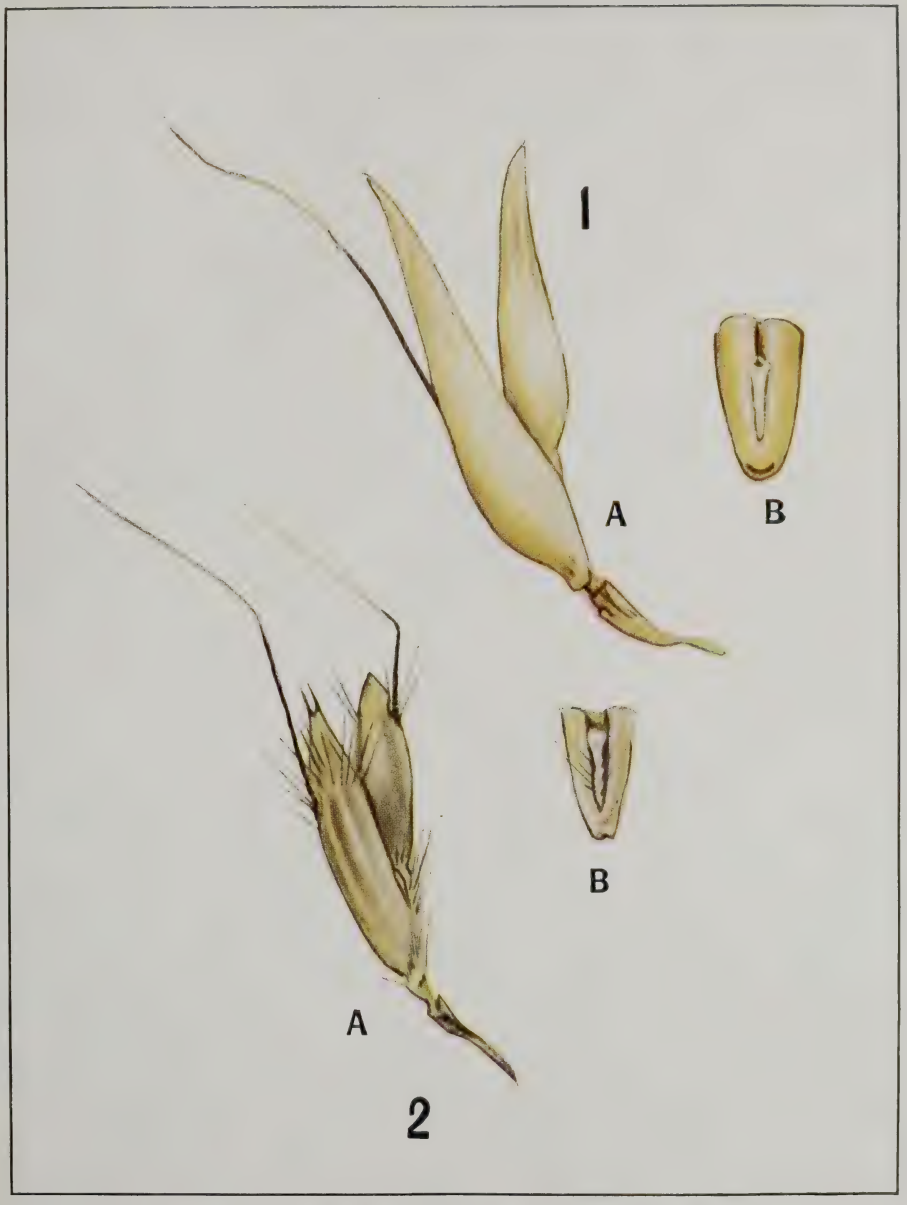
2, *Avena fatua*. A, the complete spikelet, with its strong awns and hairy lemmas; B, base of the outer grain, showing its distinct articulating surface and its rhachilla from which the inner grain easily separates.



TYPES OF SPIKELETS AND BASES OF OUTER GRAINS

1, *Avena sterilis* (cultivated form). A, the complete spikelet, with its glabrous lemmas and reduced awns; B, base of the outer grain, showing its evident articulating surface and the remnant of the rhachilla, which was torn away with the persistent inner grain

2, *Avena sativa*. A, the complete spikelet, with its glabrous lemmas and reduced awns; **B**, base of the outer grain, showing its non-articulate surface and its rhachilla from which the inner grain easily separates



TYPES OF SPIKELETS AND BASES OF OUTER GRAINS

1, *Avena sativa orientalis*. A, the complete spikelet, with its glabrous lemmas and reduced awns; B, base of the outer grain, showing its non-articulate surface and its rhachilla from which the inner grain easily separates

2, *Avena brevis*. A, the complete spikelet, showing toothed projections of the lemma; B, base of the outer grain, showing its non-articulate surface and its rhachilla from which the inner grain easily separates

SPIKELET AND BASE OF OUTER GRAIN OF AVENA STRIGOSA

A, the complete spikelet, showing the awn-points of the lemma; B, base of the outer grain, showing its non-articulate surface and its rhachilla from which the inner grain easily separates

A COLOR TYPE OF SHEATHS, LEAVES, AND GLUMES OF THE IMMATURE PLANT

A COLOR TYPE OF SHEATHS, LEAVES, AND GLUMES OF THE IMMATURE PLANT

AVENA NUDA

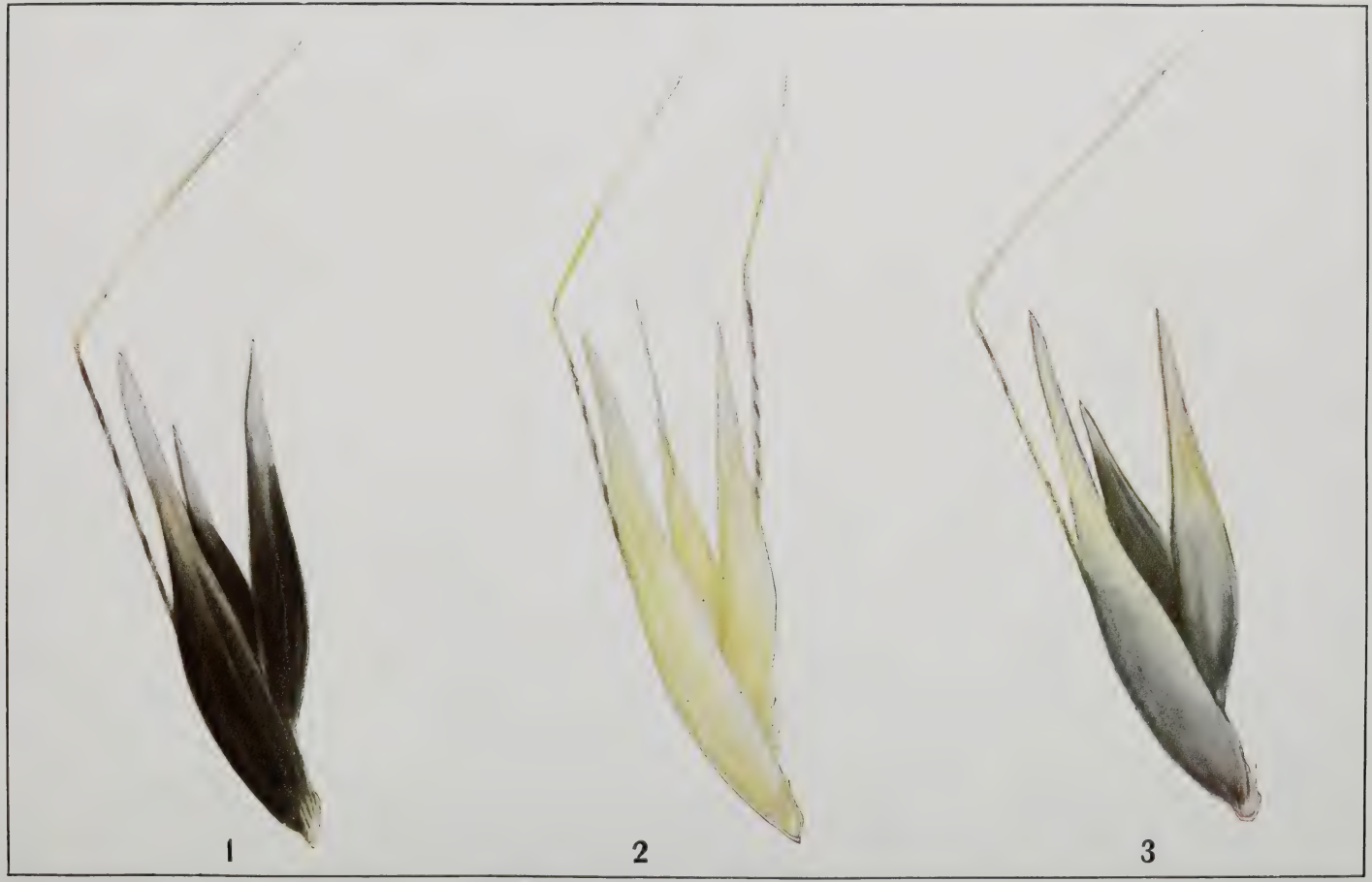
1, Complete spikelet, with elongate rhachillas; 2, a single grain (the lower) dissected to show the kernel and the loosely enveloping lemma and palea

VARIETIES OF AVENA STERILIS

1, *Avena sterilis nigra;* 2, Sterilis Selection; 3, Red Rustproof

VARIETIES OF AVENA STERILIS AND AVENA SATIVA

1, Burt (*A. sterilis*); 2, King (*A. sterilis*); 3, C. I. 606 (*A. sativa*)



AVENA FATUA GLABRATA

1, Black grain; 2, yellow grain; 3, gray grain

VARIETIES OF AVENA SATIVA
1, Winter Turf; 2, Culberson; 3, Black Norway

VARIETIES OF AVENA SATIVA

1, Victor; 2, Monarch; 3, Black Mesdag. In the case of Monarch, it has been impossible to reproduce the characteristic glaucous coating, or bloom, of the grain

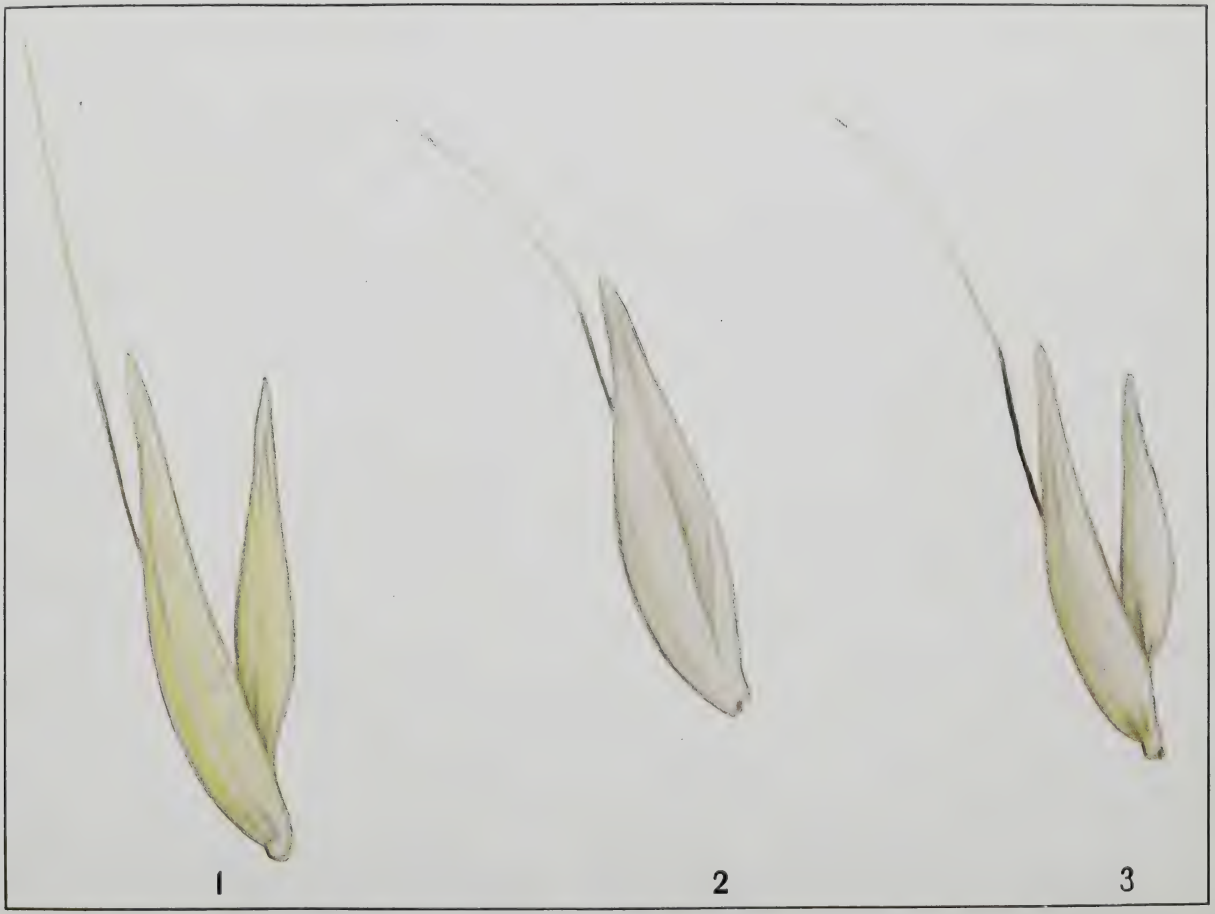
VARIETIES OF AVENA SATIVA

1, Black Diamond; 2, Monarch Selection; 3, Joannette; 4, C. I. 620; 5, Old Island Black; 6, North Finnish. In the case of Monarch Selection, it has been impossible to reproduce the characteristic glaucous coating, or bloom, of the grain

VARIETIES OF AVENA SATIVA

1, Garton 473 and Garton 691; 2, Kherson; 3, Sixty-Day; 4, Sixty-Day Selection; 5, Early Champion; 6, Awnless Probsteier

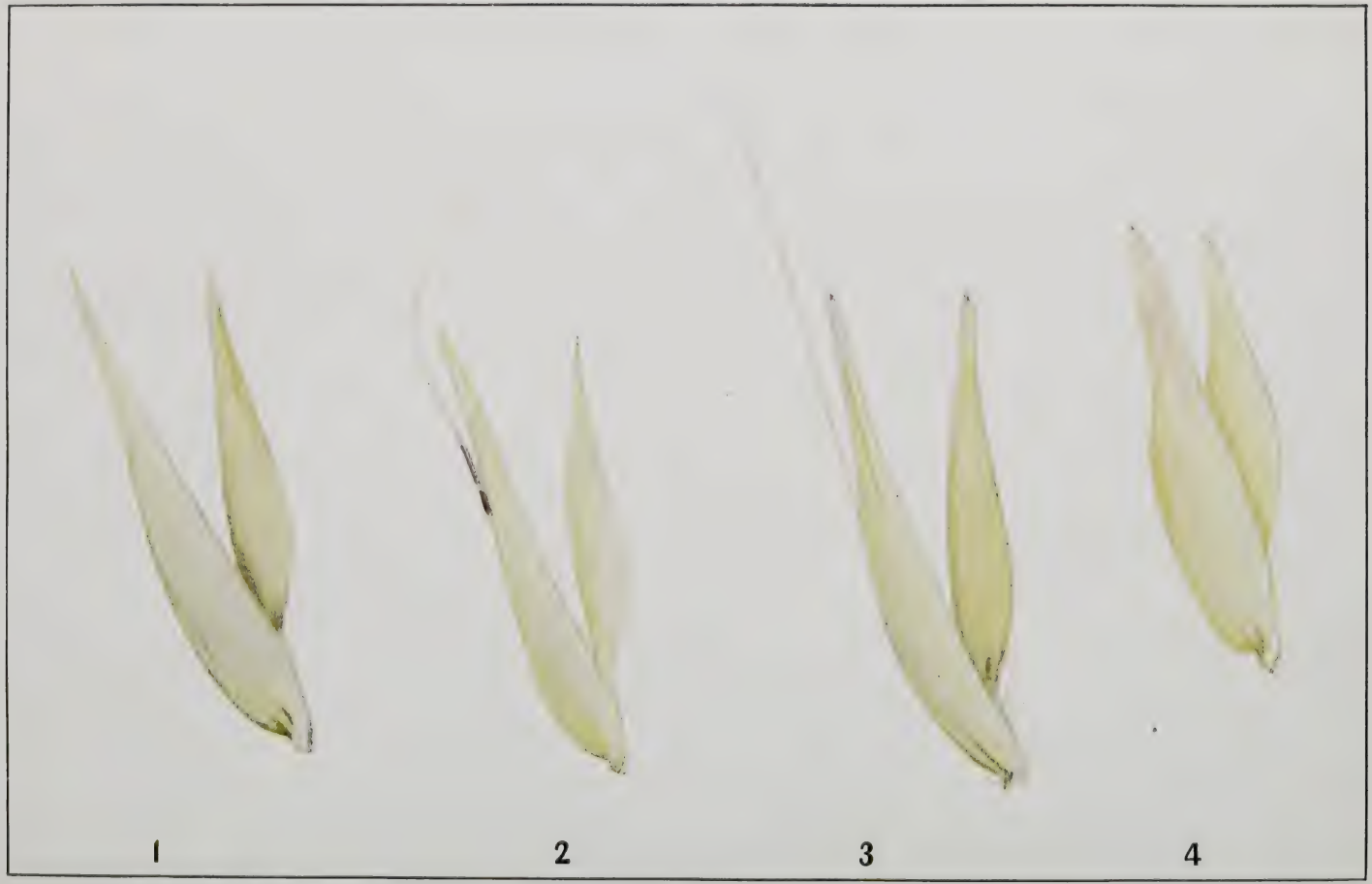
VARIETIES OF AVENA SATIVA
1, Japan Selection; 2, Golden Drop; 3. C. I. 603



VARIETIES OF AVENA SATIVA
1, Green Russian; 2, Canadian; 3, Tobolsk

VARIETIES OF AVENA SATIVA

1, Silvermine Selection; 2, C. I. 602; 3, Early Dakota



VARIETIES OF AVENA SATIVA

1, Irish Victor; 2, Danish Island; 3, Early Gothland; 4, Belyak

VARIETIES OF AVENA SATIVA

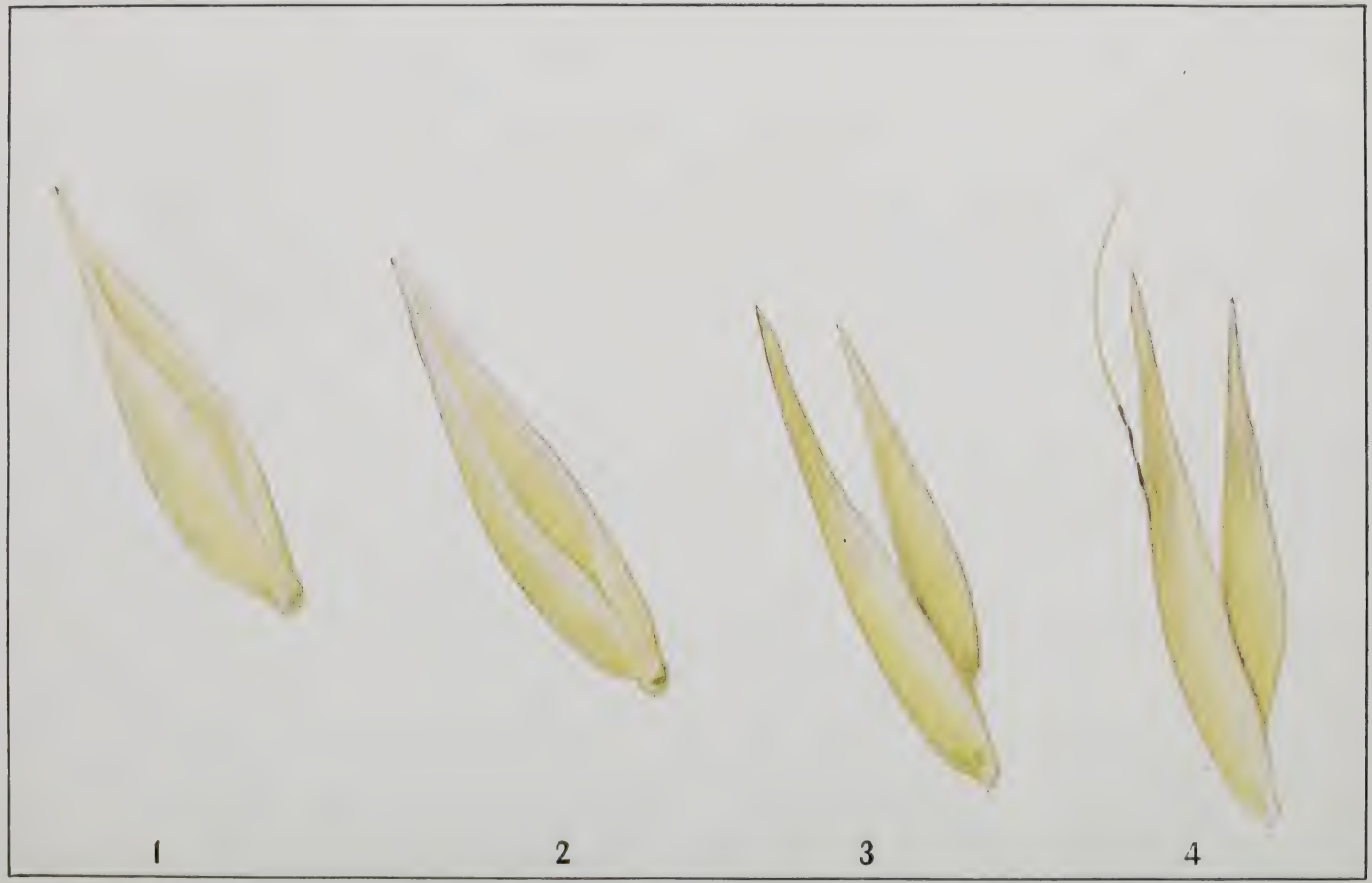
1, Silvermine; 2, Scottish Chief; 3, June; 4, Swedish Select

VARIETY LINCOLN (AVENA SATIVA), AND THREE VARIETIES OF AVENA SATIVA ORIENTALIS

1, Lincoln; 2, Garton 748; 3, Garton 784; 4, Garton Gray. In the case of Garton 784, it has been impossible to reproduce the characteristic glaucous coating, or bloom, of the grain

VARIETIES OF AVENA SATIVA ORIENTALIS

1, Black Tartarian; 2, Golden Giant; 3, Sparrowbill; 4, Garton 585



VARIETIES OF AVENA SATIVA ORIENTALIS

1. Storm King; 2, Tartar King; 3, White Tartar; 4, Green Mountain